MOONSHINE
STATUS REPORT
1 FEBRUARY 1963

Document No. 482

STAT

Approved:

STAT

Prepared by:

Copy 2 of 4

Number of Pages 55 + ii and an envelope containing 27 photographs and 1 CPM schedule

INDEX

System 1A - Operating Experience (to 31 Jan. 63)

1. RELIABILITY

Figure 1 summarizes the amount of photography and airborne runs through 31 January. Except for one run in ATP-11 where the test pilot did not operate the control panel correctly, the system has obtained useful photographs whenever operated in the air. IN 63 RUNS TO DATE, THERE HAVE BEEN NO SYSTEM MALFUNCTIONS WHICH PREVENTED THE ACQUISITION OF THE PHOTOGRAPHIC COVERAGE CALLED FOR IN THE FLIGHT PLANS.

There have been, of course, component and subsystem failures and frequently flights have been conducted without some subsystem in operation. Engineering and reliability analysis is being continued to assure that the system achieves our goal of 99% reliability and to put all subsystems into working condition. But no difficulty yet encountered has been so serious as to do more than degrade quality somewhat, and we are now fairly confident that this system can be used operationally with complete confidence that it will obtain useful photography.

Vehicle availability and weather has prevented our operating the system as often as we want. A greater frequency of flight testing is possible and desired.

2. PERFORMANCE

The performance of the 1A forward camera has been about as predicted (Ref: Letter MB-M-585), but the aft camera has produced results which are suprisingly good, better in fact than expected. Laboratory measurements indicated that the aft system was inferior to the forward system, but these laboratory measurements were made only for the axial

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

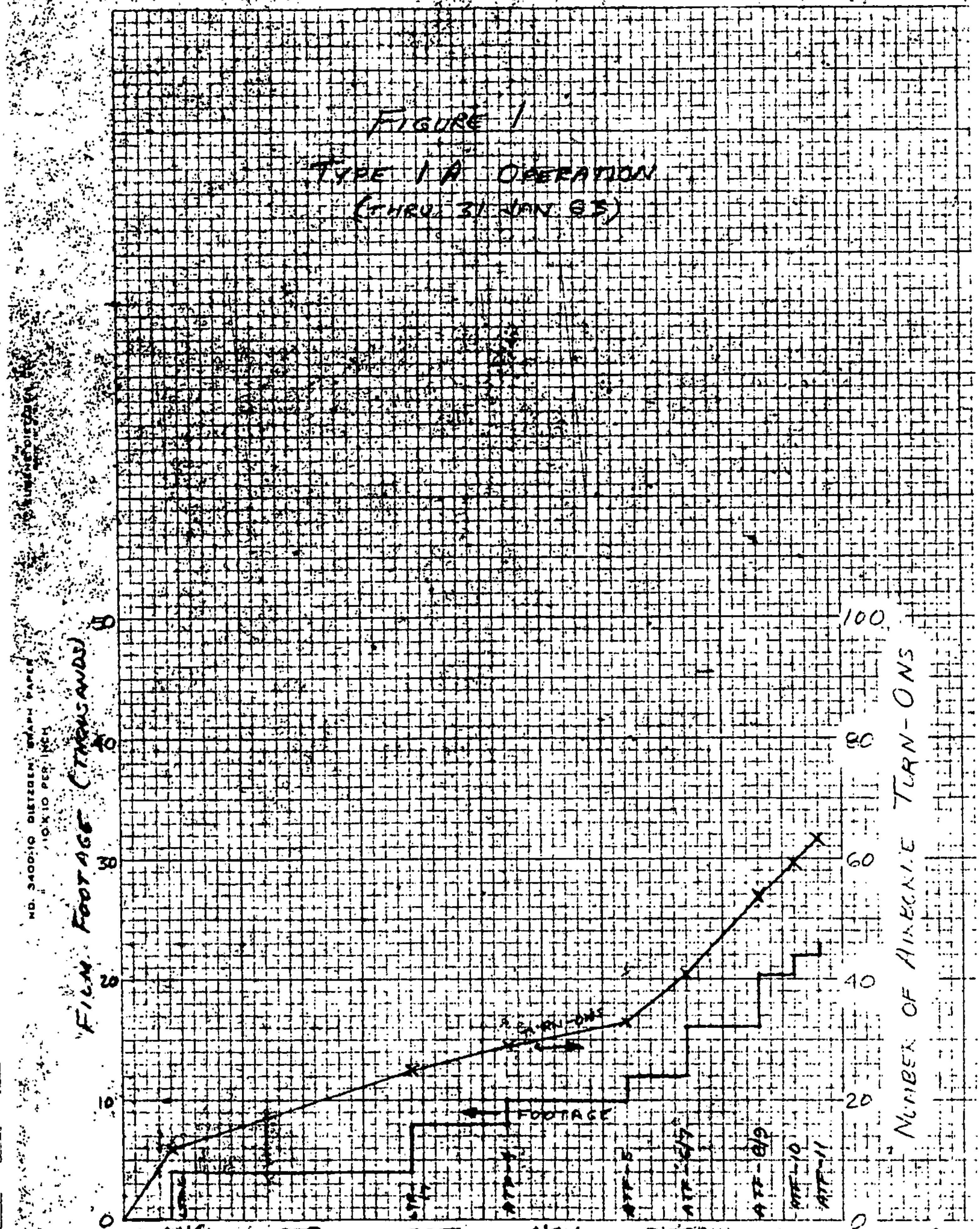


FIGURE 1
TYPE 1A OPERATION
(THRU 31 JAN 65)
FILM FOOTAGE (THOUSANDS)
0
10
20
30
40
50
NUMBER OF AIRBORNE TURN-ONS
0
20
40
60
80
100
A/B TURN-ONS
FOOTAGE
ATP-4
ATT-5
ATT-6/7
ATT-8/9
ATT-10
ATT-11

nadir image. Since airborne performance data is obtained from other image points and is also affected by each camera's angular aiming and windows, this excellent performance is possible.

Table 1 is a recapitulation of performance on flights over air force targets. All images which were obtained are included, regardless of system condition. The marked improvement in later flights is therefore a reflection of improvement in stabilization, IMC, and V/h programming as well as having more altitude.

Further improvement in performance can be expected when (1) the V/h sensor is activated, (2) improvements are made to boresighting and platform alignment, (3) some modifications are made to the stabilization-pointing subsystem, (4) better scanner flats are placed on the forward optical system, and (5) the altitude of operation is increased. The performance will continue to show a spread since many uncontrollable factors limit the resolution that can be achieved, but it is reasonable to expect both the median and maximum performance levels to increase.

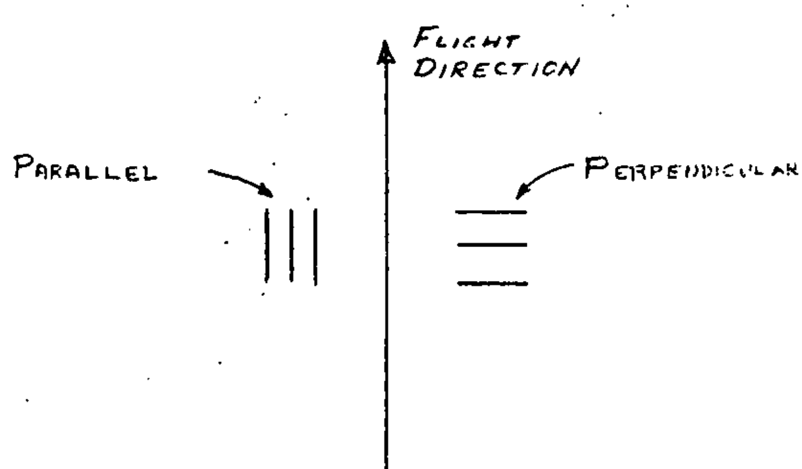
3. OPERATIONAL IMPLICATIONS

At the present time, the system requires about ninety seconds to reach full film speed from the time the system is switched from standby to operate mode. We feel that our original goal was thirty seconds, based on coming out of a vehicle maneuver reasonably near a target. (Ref: Area 7541 and Hq. 1412). However, we have now found (accidently, in ATF 8, runs 2 and 3) that the system can safely be left on in turns. Although the system is caged in turns and IMC is imperfect, the ability to so operate the system increases operational flexibility and provides freedom to take evasive action if required.

FLIGHT NUMBER & PARAMETER \ CAMERA & TARGET ORIENTATION		FORWARD CAMERA		AFT CAMERA	
		PERPENDICULAR (LONG)	PARALLEL (SHORT)	PERPENDICULAR (LONG)	PARALLEL (SHORT)
MEDIAN RESOLUTION	ATF 6/7	64	58	30	54
	ATF 8/9	64	83	70	68
	ATF 10	70	56	86	122
MAXIMUM RESOLUTION	ATF 6/7	93	82	67	90
	ATF 8/9	104	122	140	148
	ATF 10	163	135	128	152

TABLE 1 - Performance Recapitulation

ORIENTATION EXPLANATION:



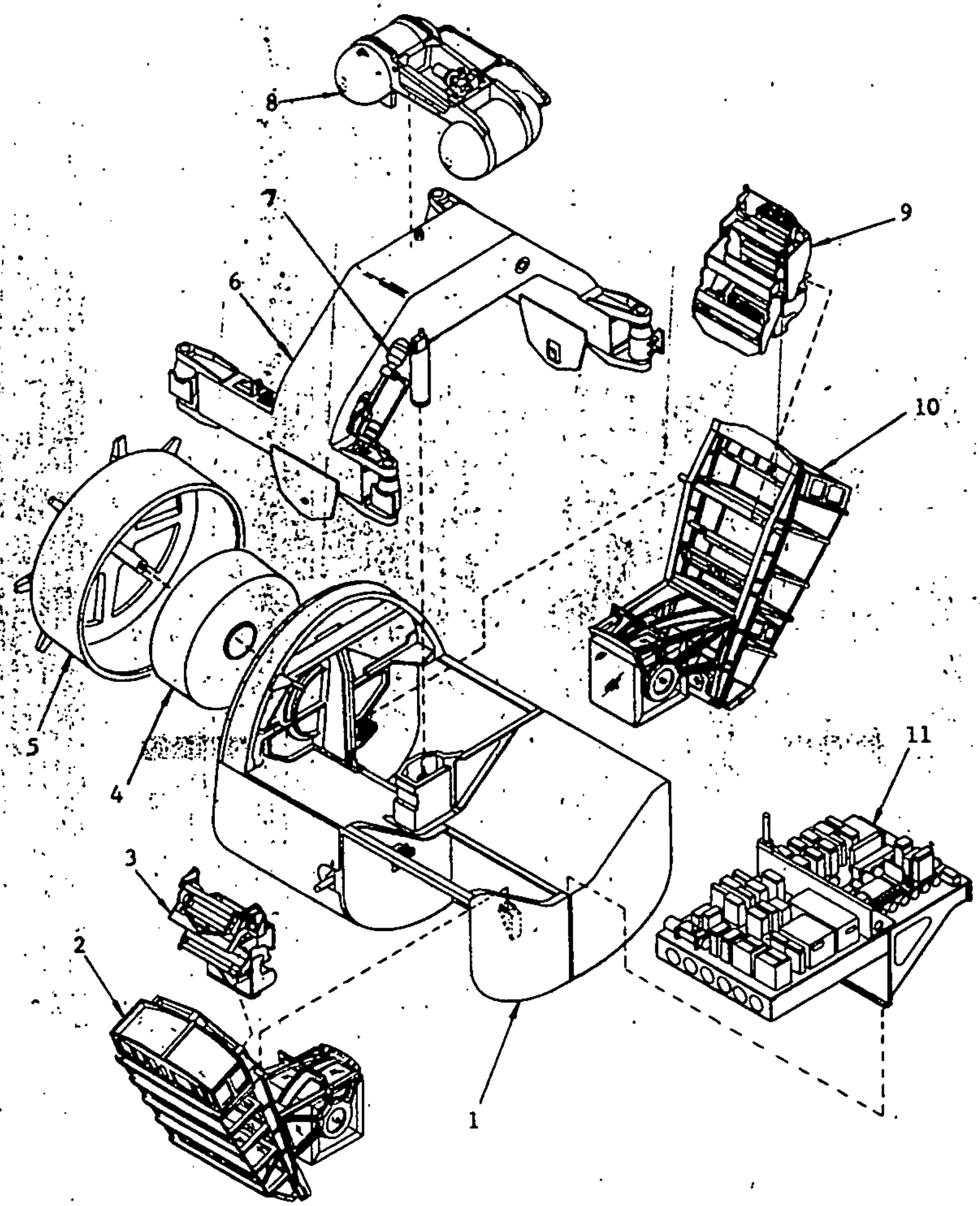
The only remaining disadvantage of the longer start-up time is that targets of opportunity cannot be picked up on the large field of view of the periscope (79 seconds maximum anticipation); but we understand that the small field of the periscope (18 seconds maximum anticipation) will be used normally. Since this system was never intended for use on targets of opportunity and is now known to work in turns, we feel that the present start-up time in no way inhibits operational use of the system.

Although we have a rather limited amount of data, it appears that pre-programmed exposure produces good results. If desired, an operator override control would be easy to install since the exposure control is in the operator's console. Similarily, the system has stayed in focus, as far as we can tell, through a wide range of (cold rather than warm) temperatures, and we are reasonably confident that the catadioptric lens will not require any elaborate focus sensor and control system.

Finally, our operating experience convinces us that the system is easy to maintain, install and operate, and we are confident that it can be operationally committed frequently, even on successive days if necessary. It is, of course, a complex system and servicing it can be difficult, but we know of nothing that will normally require lengthy servicing in routine operation.

4. RETROFITS

A series of retrofits have already been made (notably the analgesic for the aft optical system and the start-up package) and additional retrofits are forthcoming (notably the operators control for test flights and stabilization). Activation of the heading reference and latitude repeater as well as continued testing may reveal the need for other retrofits, which will be made as required.



1. Platform Structure
2. Aft Optical Bench and Scanner Assembly
3. Aft Shuttle and Shuttle Holder
4. 5000 Ft. Film Supply Spool
5. Film Take-Up Cassette
6. Frame Assembly
7. Caging Helium Supply
8. Film Transport Helium Supply Assembly
9. Fwd Shuttle and Shuttle Holder
10. Fwd Optical Bench and Scanner Assembly
11. Electronics Bridge Assembly

Q-Bay Package 1A and 1B Major Assemblies

System 1B - Status Report (as of 24 Jan. 63)

1. AFT CAMERA

A. Aft Optical Bench

The aft optical bench has been completely assembled, aligned and tested. Test results are shown in Figures 2-5.

B. Aft Shuttle Assembly

The aft shuttle has been completely assembled, wired and focussed and is presently undergoing qualification tests.

C. Capping Shutter and Drive Assembly

The capping shutter drive assembly is 85% complete. The remaining sub-assembly to be incorporated is the drive motor assembly. All parts are on hand and assembly is in process.

The capping shutter assembly has been completed and is installed on the aft optical bench.

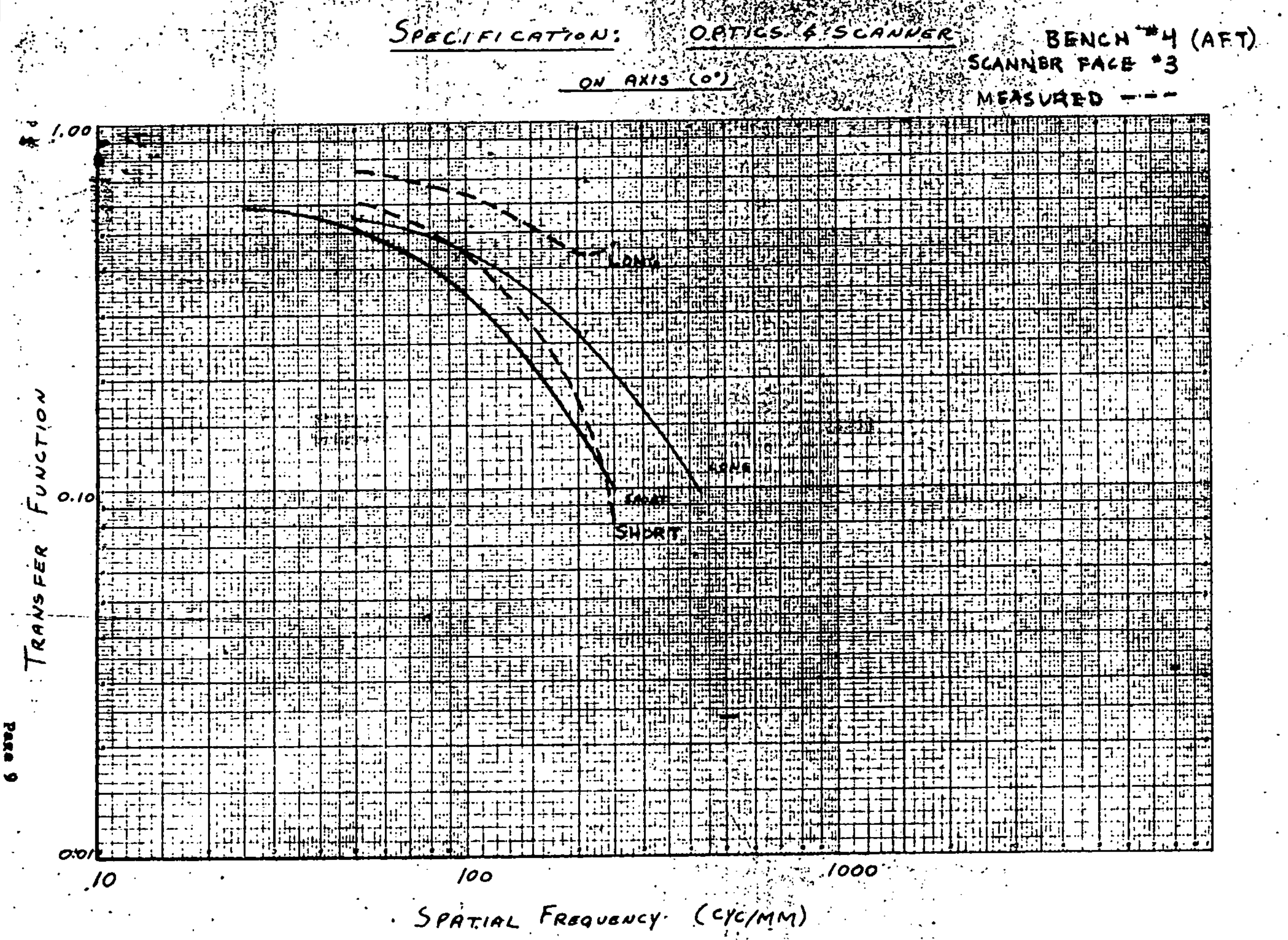
D. Aft Scanner and Drive Assembly

The aft scanner has been assembled, aligned and installed on the optical bench.

Parts for the aft scanner drive assembly are on hand and assembly is in process.

E. Aft Bench Light Shields

Light shields for the aft bench have been received. Inspection of some shields indicate improper fabrication. Those that have been accepted by inspection have been assembled to the bench, the others have been sent back to the vendors for correction.



SPECIFICATION: OPTICS & SCANNER
ON AXIS (0°)
BENCH #4 (AFT)
SCANNER FACE #3
MEASURED ---
1.00
0.10
0.01
10
100
1000
LONG
SHORT
TRANSFER FUNCTION
SPATIAL FREQUENCY (CYC/MM)

Figure 2

SPECIFICATION: OPTICS & SCANNER   BENCH #4 (AFT)

ON AXIS (0°)   SCANNER FACE #118

MEASURED ---

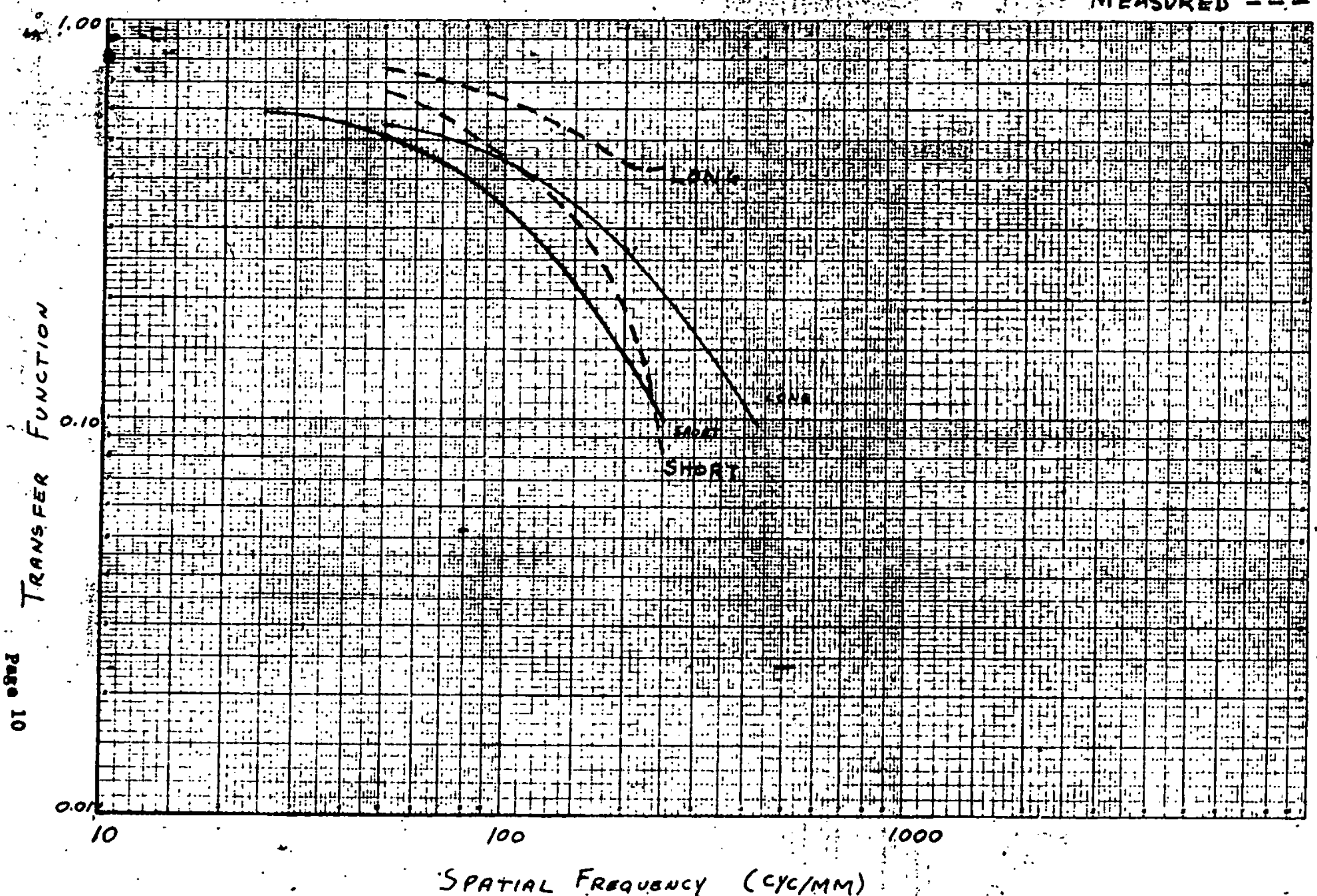


Figure 3

SPECIFICATION: OPTICS & SCANNER

ON AXIS (0°)

BENCH #4 (AFT)
SCANNER FACE #35
MEASURED ---

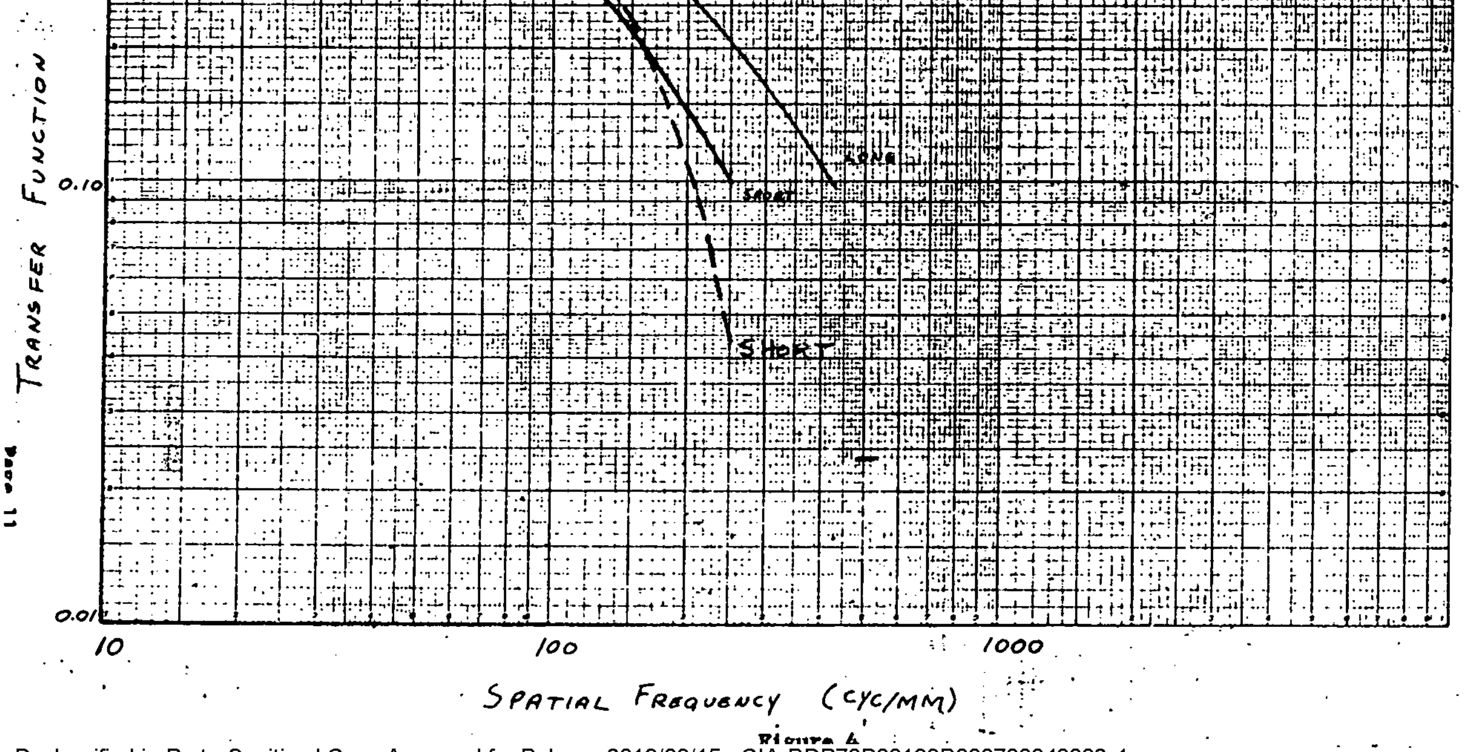


Figure 4

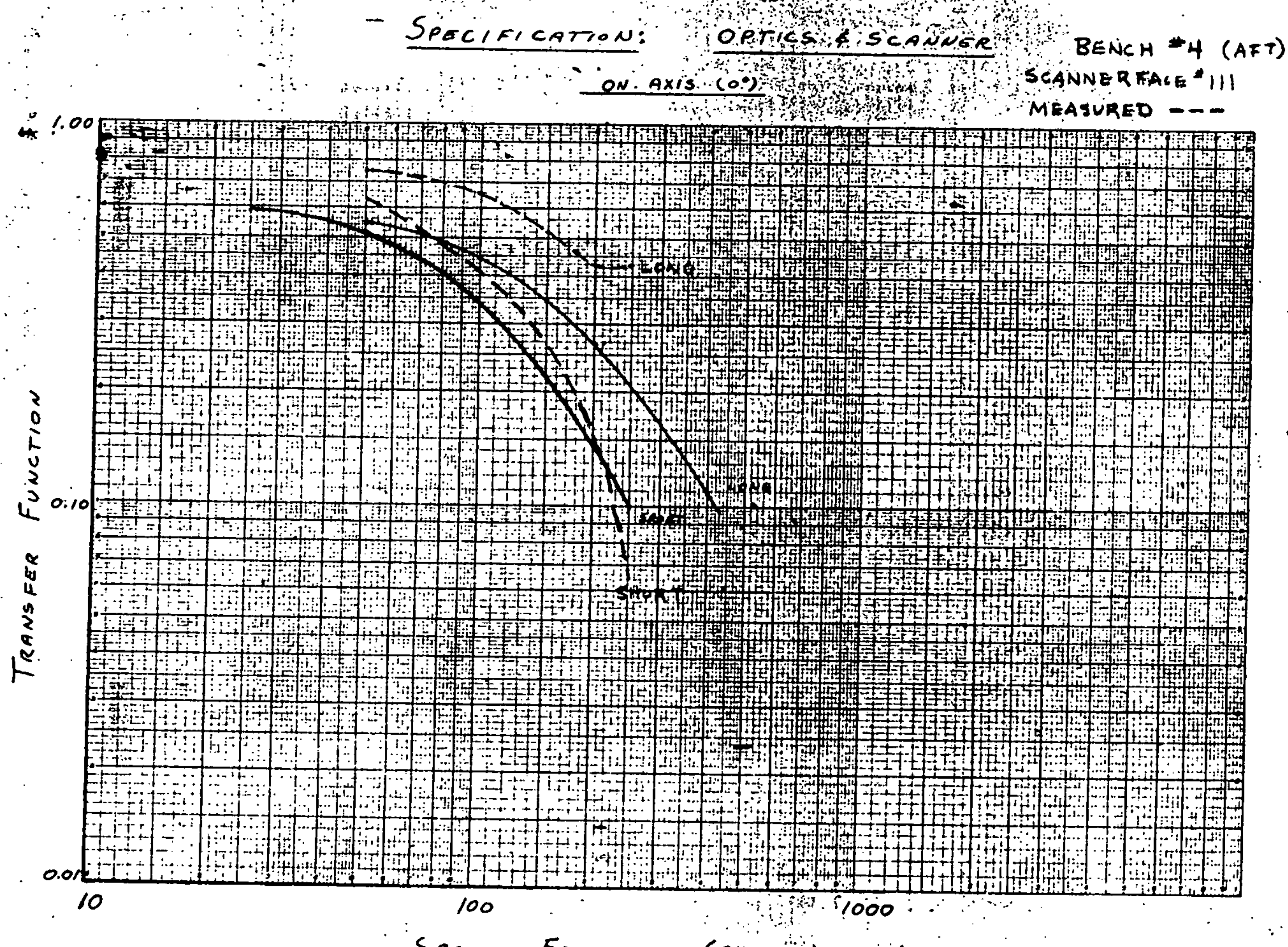

SPECIFICATION: OPTICS & SCANNER
ON. AXIS (0°)
BENCH #4 (AFT)
SCANNER FACE #111
MEASURED ---
LONG
SHORT
1.00
0.10
0.01
10
100
1000
TRANSFER FUNCTION
SPATIAL FREQUENCY (CYC/MM)

Figure 5

2. FORWARD CAMERA

A. Forward Optical Bench

The forward optical bench has been completely assembled, aligned and tested. The results are shown in Figures 6-9.

B. Forward Shuttle Assembly

It was found that the forward shuttle assembly during the alignment check could not come within the specified critical tolerances. It was necessary to disassemble the unit and replace certain critical parts. Reassembly is in process.

C. Capping Shutter and Drive Assembly

The capping shutter drive assembly is 85% complete. The remaining sub-assembly to be incorporated is the drive motor assembly. All parts are on hand and assembly is in process.

The capping shutter assembly has been completed and is installed on the forward optical bench.

D. Forward Scanner and Drive Assembly

The forward scanner has been assembled, aligned and installed on the optical bench.

Parts for the forward scanner drive assembly have been ordered and are scheduled for 28 January 1963 delivery.

E. Forward Bench Light Shields

Light shields have been installed in the forward optical bench.

3. PLATFORM ASSEMBLY

A. Supply Drive Assembly

The supply drive assembly has been completed and installed

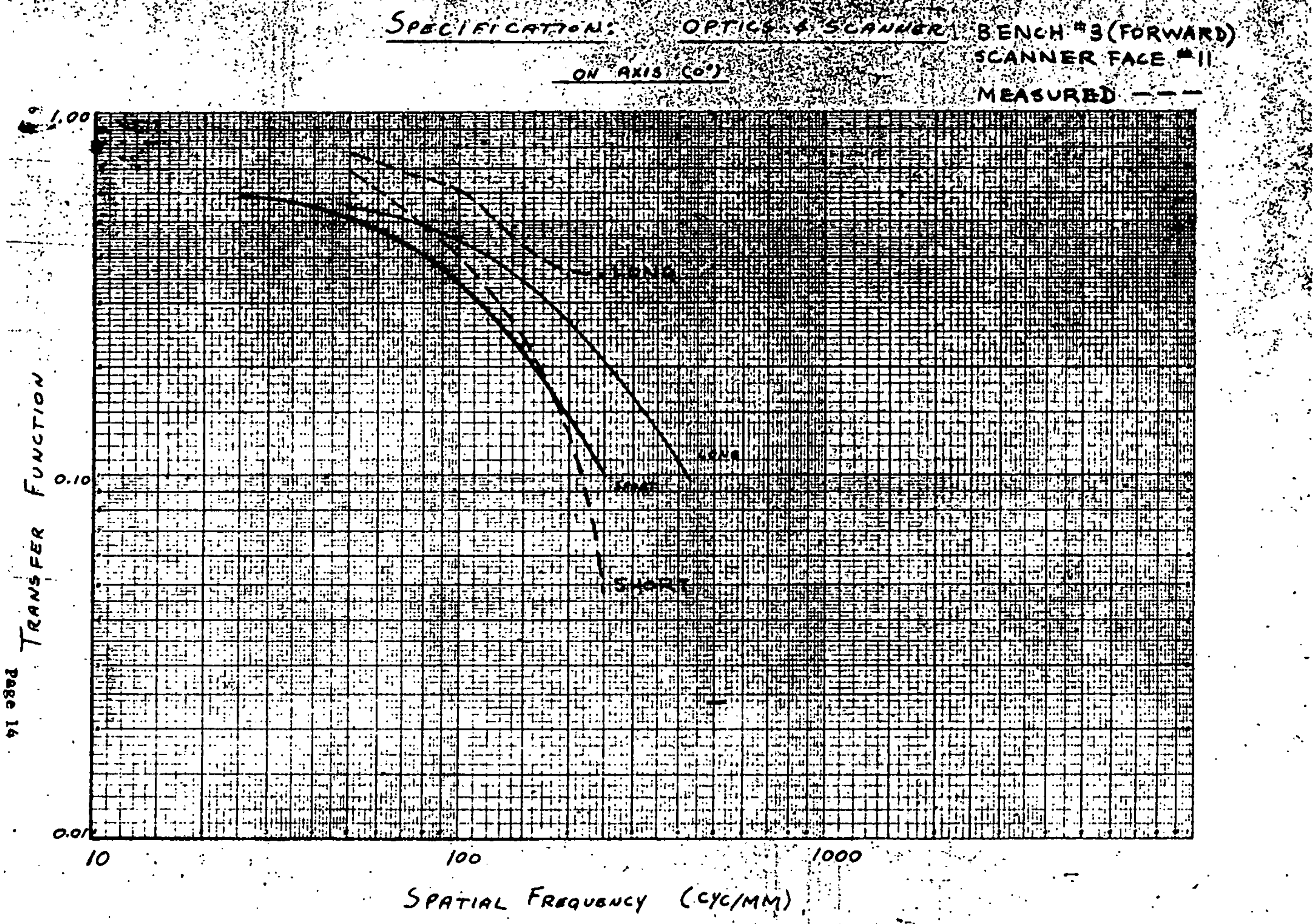

SPECIFICATION: OPTICS + SCANNER
ON AXIS (0°)
BENCH #3 (FORWARD)
SCANNER FACE #11
MEASURED ---
1.00
0.10
0.01
10
100
1000
LONG
LONG
SHORT
SHORT
TRANSFER FUNCTION
SPATIAL FREQUENCY (CYC/MM)

Figure 6

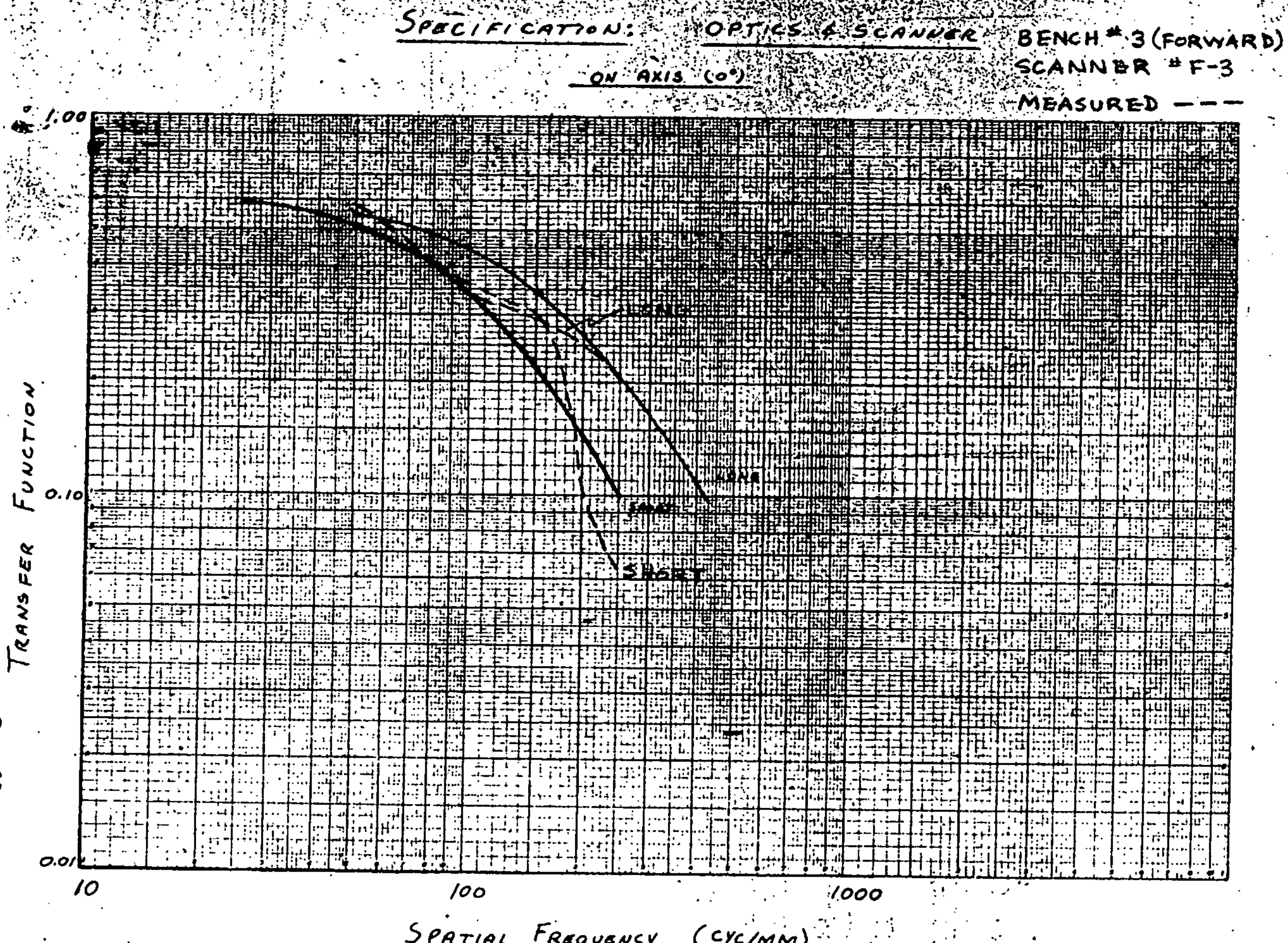

SPECIFICATION: OPTICS & SCANNER
ON AXIS (0°)
BENCH # 3 (FORWARD)
SCANNER # F-3
MEASURED ---
1.00
0.10
0.01
TRANSFER FUNCTION
LONG
SHORT
10
100
1000
SPATIAL FREQUENCY (CYC/MM)

Figure 7

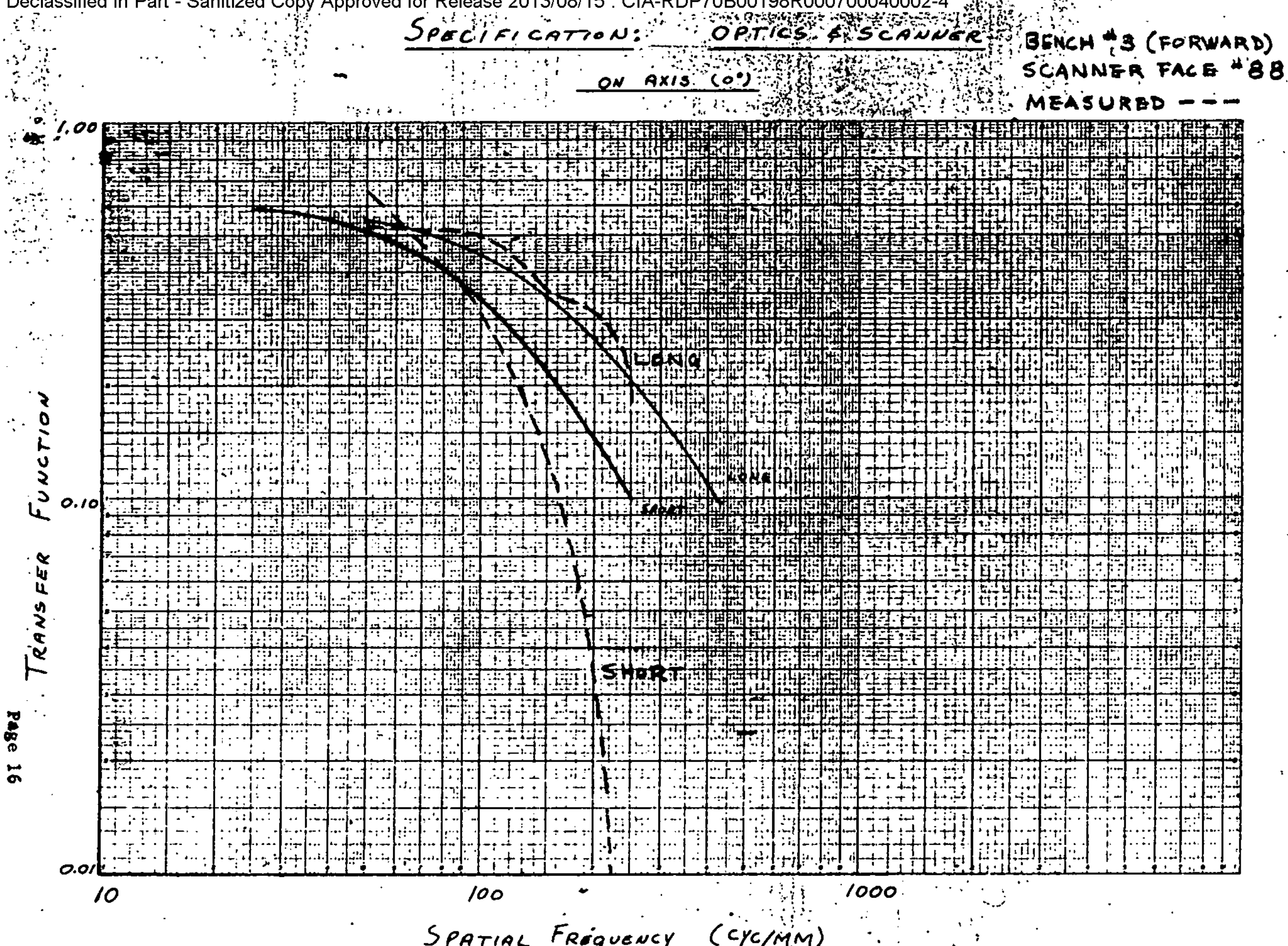

SPECIFICATION: OPTICS & SCANNER
ON AXIS (0°)
BENCH #3 (FORWARD)
SCANNER FACE #88
MEASURED - - -
1.00
0.10
0.01
10
100
1000
LONG
SHORT
LONG
SHORT
TRANSFER FUNCTION
SPATIAL FREQUENCY (CYC/MM)

Figure 8

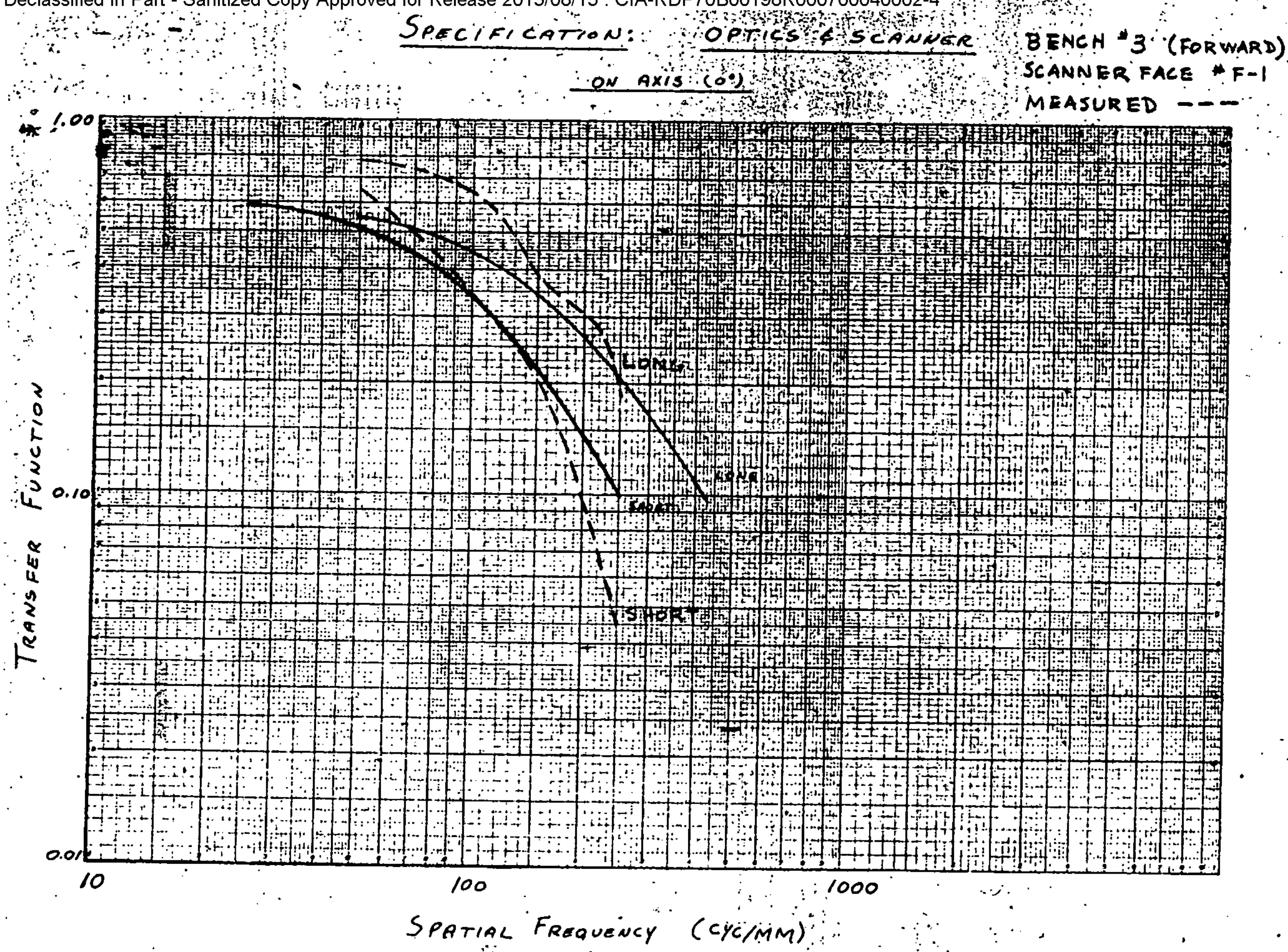

SPECIFICATION: OPTICS & SCANNER
ON AXIS (0°)
BENCH #3 (FORWARD)
SCANNER FACE #F-1
MEASURED ---
1.00
0.10
0.01
TRANSFER FUNCTION
LONG
SHORT
10
100
1000
SPATIAL FREQUENCY (CYC/MM)

Figure 9

on the platform. On this system the belt drive is replaced by a gear drive.

B. Inner and Outer Hub Drive Assembly

The inner and outer hub drive assembly (supply and take-up hubs) have been completed and installed on the platform.

C. Take-Up Drive Assembly

The take-up drive assembly has been completed and installed on the platform.

D. Knuckle Assembly

The knuckle assembly including the azimuth torquer assembly has been completed and installed on the platform. A modification incorporating a torsion bar is under consideration.

E. Light Shields

Fitting of light shield bracketry to the platform has been completed.

E. Film Transport Sub-assemblies

Fitting and installation of film transport sub-assemblies (such as tension sensors, cross-over network, etc.) on the platform is in process.

Cassette castings received and ready for machining.

G. Wiring of Platform

The necessary harnessing, connector bracketry, connector installation on the platform is in process. Present percentage of completion is approximately 10%.

4. ELECTRONICS BRIDGE ASSEMBLY

A. Electronics Components

Installation of electronic components such as amplifiers, power-supplies etc. on the platform is in process.

B. Wiring

Wiring of components, connectors, etc. on the bridge is in process.

Present percentage of completion of electronic bridge assembly is approximately 65%.

5. STABILIZATION

A. Pitch Weight Shifter

The pitch weight shifter has been assembled, wired and is ready for testing.

B. Roll Weight Shifter

The roll weight shifter has been assembled, wired and is ready for testing.

C. Attitude Sensor

The attitude sensor has been assembled, wired and tested.

D. Attitude Reference Assembly

Parts for the attitude reference are on hand. Assembly has not been started. This is one of the last assemblies required.

E. Gyro Package

The gyro package has been completed and is presently being used in breadboard stabilization tests.

6. SYNCHRONIZER ASSEMBLY

The synchronizer has been assembled wired and tested.

7. DATA CHAMBER

The data chamber has been assembled, wired and tested.

The connector on the system 1A data chamber was a source of trouble in the field, therefore a connector from another manufacturer was substituted on chamber for system 1B.

8. V/H SENSOR AND INTERFACE

A. V/H Sensor

The V/H sensor from system 1A is undergoing tests. A modified V/H sensor with a new light pipe is scheduled for February 1 completion. If performance is tremendously improved, the 1A sensor will be modified accordingly and used in system 1B.

B. V/H Interface

The V/H interface is approximately 75% complete. This package will be similar to system 1C package.

C. Start-Up Package

The start-up package is complete and undergoing tests.

9. FRAME ASSEMBLY

The cager helium supply, plumbing, etc. are being installed on the frame.

10. HELIUM TANKS

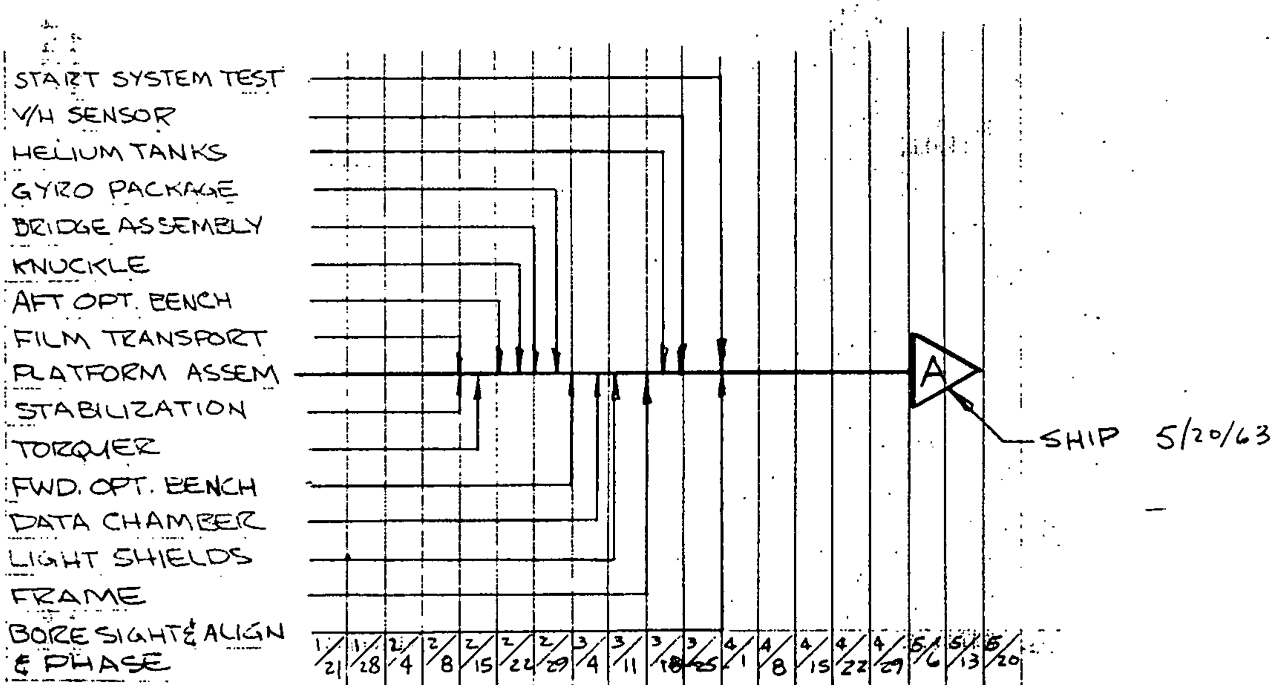
The helium tanks were ordered and received. Of the two required for this assembly, one was loaned to the vehicle manufacturer. Additional tanks are on order and should be received in time to complete this assembly on schedule

11. SYSTEM 1B SCHEDULE

See Figure 10 for 1B system assembly schedule. Generally, THIS SCHEDULE HAS BEEN MET IN LAST SIX MONTHS.

12. CONCLUSION

The preceeding items comprise one complete system and by comparing the status of the items to the schedule in Figure 10 and the photographs a feeling for the status of system 1B can be obtained.



MAIN SYSTEM ASSEMBLY #2.

1-8-63

Figure 10

System 1C - Improvements

1. SUMMARY

The principal areas of improvements of system 1C over systems 1A and 1B are the stabilization system and the film and scanner drives and control. A concentrated effort is also being made to improve the following areas:

A. Start up and operational control.

B. Component reliability.

C. Structural rigidity.

D. Electronic packaging.

E. Accessibility of components for servicing.

F. Operational testing.

These areas will be discussed in some detail in the following sections.

2. SCANNER AND FILM DRIVES

The attainment of highly precise synchronization between scanner and film motions is probably the most difficult control problem which confronts the designer of high resolution panoramic type camera systems.

A considerable effort was made to provide for precise scanner and film drives in system 1A, the result of that effort culminating in just about the ultimate smoothness of performance achievable with drives employing geared and belt drives servo motors and synchros. The performance is limited only by disturbance torques due to gearing and bearing friction and scanner and film drive velocity sensor errors.

The design philosophy of system 1C is to provide an ultimate system whose performance is limited primarily by the film-optics-seeing combination. In conformance with that philosophy, the decision was made to incorporate rather drastic modifications in the system 1C film and scanner drive control system as follows:

A. Reduce to an absolute minimum the number of elements which produce torque disturbances.

B. Precisely measure the velocity variations of the capstan and scanner <u>at the capstan and scanner</u>.

The design not only improves performance but simplifies the overall design by eliminating the belts and gear trains, as well as the complex synchronizer servo used in the system 1A and 1B scanner and film drive controls.

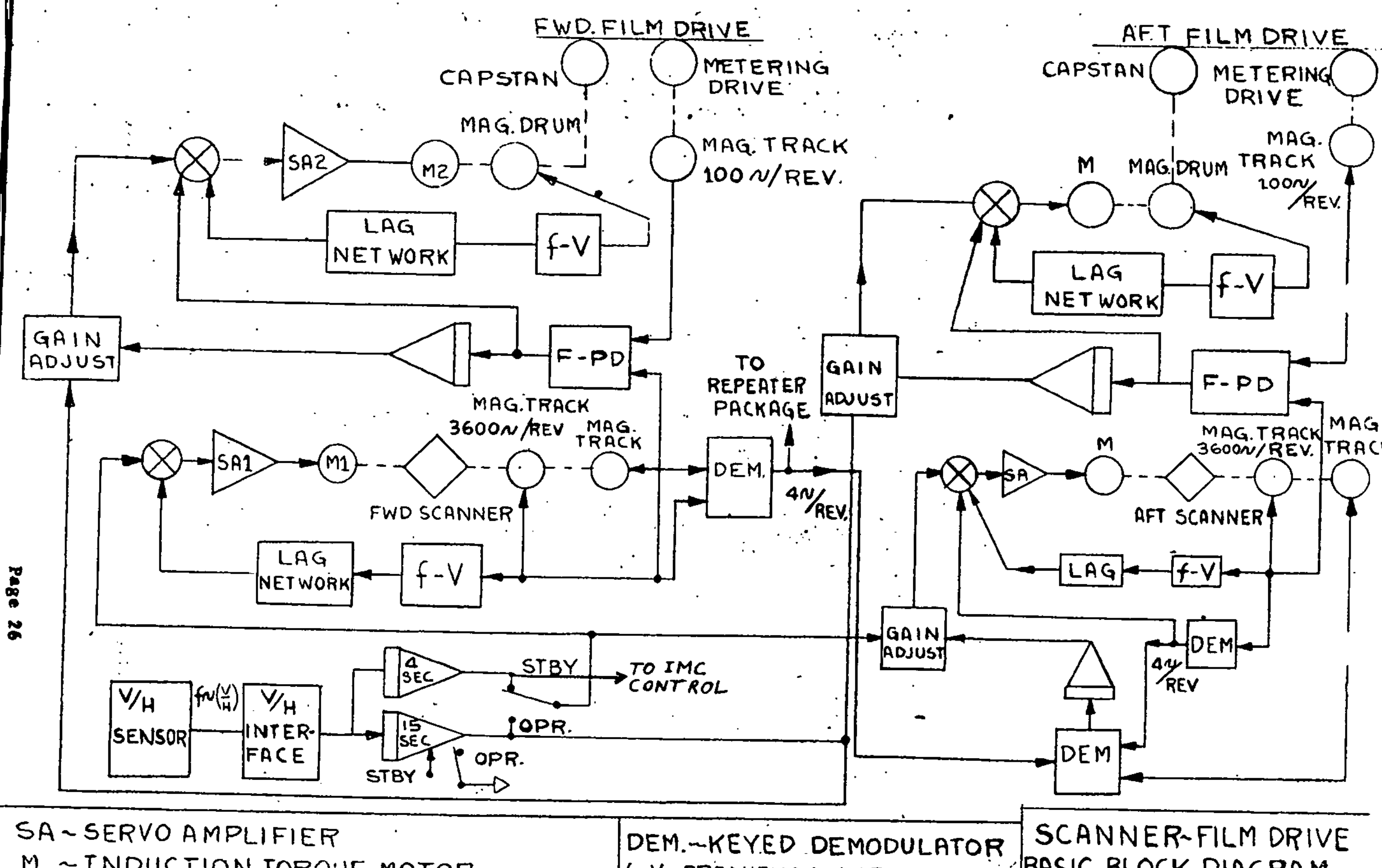
In order to minimize torque disturbances, we are removing most sources of disturbances. All gearing or coupling between scanner or film capstan drives and transducers or motors is eliminated. The only remaining torque disturbances consist of bearing noise, unbalance torques, and torques transmitted by the film to the capstan drive. A considerable effort is being made to minimize bearing friction as well as static and dynamic balancing errors. Drag cup induction motors (A.C. torque motors) are used to directly drive the capstan and scanners. This type of motor virtually eliminates torque variations due to slot effect or mechanical and electrical assymetries.

In order to provide for optimum control of scanner and capstan angular velocities, it is essential to precisely measure these

these rates to high precision. For optimum control it is necessary to directly measure the rate of the device being controlled without introducing coupling errors between capstan or scanner and the velocity transducer. This is being accomplished by using high bit density magnetic track mounted directly on the capstans and scanners. A voltage proportional to the bit rate from the magnetic track is developed for velocity control.

Figure 11 shows the basic block diagram of the System 1C scanner and film drive control system. Scanner and film drive rates are controlled primarily by a voltage derived from the V/h subsystem. Two V/h voltages are utilized, the first is smooth through a lag network with a time constant of 4 seconds and the second is smoothed through a lag network with a time constant in the order of 15 seconds. The 4 second smoothed V/h signal is used for IMC during operate and to drive the scanners during "Standby" operation. The 15 second smoothed V/h signal is set to zero during "Standby" and provides an exponentially rising V/h voltage during "Operate". The latter voltage controls the film drives as well as the film supply and take up reels. The slowly rising V/h control voltage permits synchronous start-up operation of the film drive control elements. In addition the heavily smoothed V/h signal will provide for a steady velocity control voltage of the scanner and film drives.

The angular velocity of the forward scanner is directly controlled by the V/h voltage. The velocity servo control system consists of a 3600 cycle/revolution magnetic track transformed into a voltage proportional to frequency by means of a frequency to voltage converter (f - V), a lag network, servo amplifier (SA1), and drag cup motor (M1).



SA ~ SERVO AMPLIFIER
M ~ INDUCTION TORQUE MOTOR
MULT ~ MULTIPLIER
F-PD ~ FREQUENCY-PHASE DISCRIMINATOR

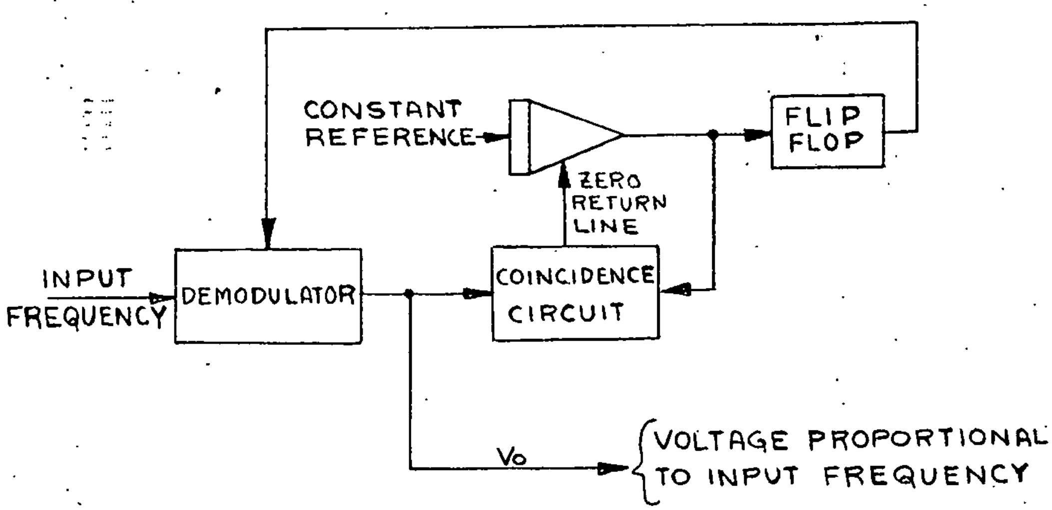
DEM. ~ KEYED DEMODULATOR
f-V ~ FREQUENCY VOLT. CONVERTER
▷ ~ INTEGRATOR

SCANNER-FILM DRIVE
BASIC BLOCK DIAGRAM
SYSTEM IC

FIG. 11

A block diagram of the frequency to voltage converter is shown in Figure 12. The circuit consists of an integrator, the output of which increases at a constant rate. The output is returned to zero when voltage, V_o, is reached. The frequency of the resulting saw tooth wave thus depends on the magnitude of V_o. The saw tooth wave form is transformed into a square wave by means of the "flip-flop" circuit. The resulting square wave, together with the input signal, are put through a keyed phase sensitive demodulator to produce voltage V_o.

The forward capstan film drive basically operates on the same principle as the forward scanner drive. The capstan velocity is controlled by a voltage proportional to V/h by means of a capstan mounted magnetic drum giving a frequency proportional to capstan speed, a frequency to voltage converter (f - V) a lag network, a servo amplifier (SA2) and a direct coupled drag cup motor, M2. This portion of the control will provide for a capstan speed which will precisely follow the V/h control voltage. Slight differences in speed to voltage scale factor would, however, produce an incorrect capstan velocity. In order to provide the correct speed to voltage scale factor, a 100 cycle per revolution magnetic drum is placed on the 2 inch diameter metering drive. When the film is being driven at the correct speed, the resultant frequency from this magnetic track must be identical to that produced by the 3600 cycle per revolution scanner track. These two frequencies are compared in a "frequency-phase discriminator" which produces a voltage proportional to phase difference when the frequencies are the same and a plus or minus d.c. error signal when the frequencies are not the same. The integrated output voltage of the "frequency-phase



BLOCK DIAGRAM
FREQUENCY TO VOLTAGE CONVERTER
SYSTEM 1C

FIG. 12

discriminator" automatically adjusts the gain of the V/h voltage.

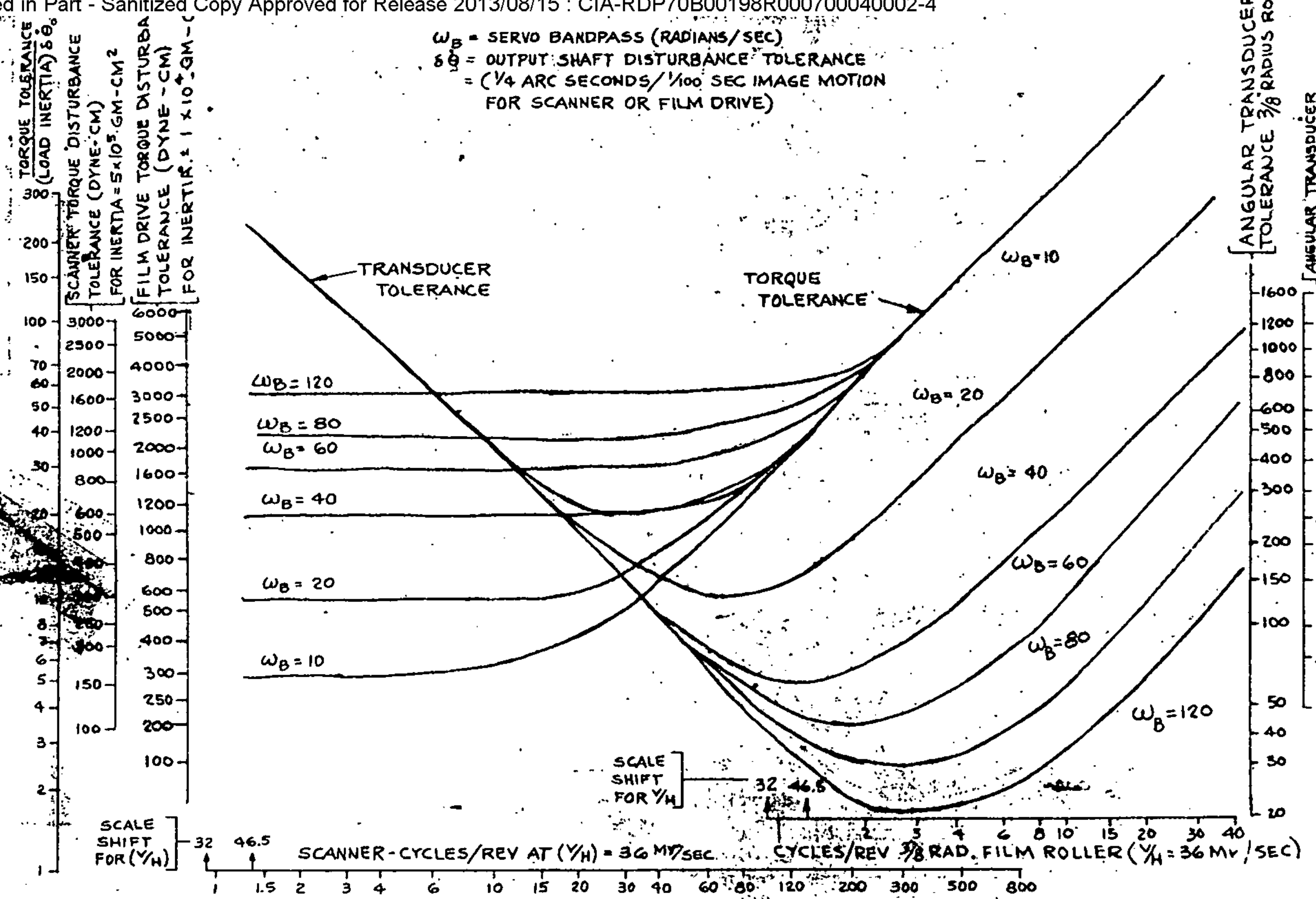
A suitable "frequency-phase discriminator" is presently manufactured by Sequential Electronic System, Incorporated. A non-volatile integrator and automatic gain adjustment presently in the breadboard stage consists of a feedback amplifier driven non-spring returned D'Arsonval type meter movement driving an infinite resolution potentiometer.

The aft scanner and film capstan drive are controlled by a voltage proportional to V/h. Synchronization between scanners is accomplished by the generation of a 4 cycle per scanner revolution signal from each scanner and controlling the gain of the aft scanner V/h control voltage until these signals are synchronous. The 4 cycle per revolution control signals are generated by means of additional magnetic tracks on each of the scanners. These tracks are phase modulated with respect to the 3600 cycle per revolution tracks so that the demodulated signals produce the 4 cycle per revolution wave form. The two signals are compared in a demodulator and adjust the V/h input scale factor of the aft scanner through a non-volatile integrator.

Synchronization between aft scanner and aft film drive is accomplished in the same manner as between forward scanner and film drive.

Velocity variations are introduced in scanner and film drives by torque load variations and by errors in the magnetic tracks. The effect of these errors is shown in Figure 13. This figure assumes an image degradation tolerance of 1/4 arc seconds for 1/100 seconds exposure time due to scanner or film drive velocity error for each of the causes of that error. Torque disturbance and transducer error tolerances are plotted as a function of cycles per revolution of the

[redacted]



SCANNER & FILM DRIVE TORQUE DISTURBANCE TOLERANCE
& TRANSDUCER ACCURACY REQUIREMENTS

FIG. 13

sinusoidal disturbances for various values of velocity servo bandpass. For example, for a scanner, it is expected that the high frequency transducer positional error will not exceed 1 arc second. Such an error limits the servo bandpass to 40 radians per second and allows a torque variation tolerance to only 600 dyne-cm over a frequency range from 1 to 60 cycles per scanner revolution. In order to obtain this low magnitude of torque variation, extreme care is being used to minimize bearing friction, to dynamically and staticly balance the scanners, and to minimize motor torque variations. 20 microinch bearings are used in the scanner drive. In order to maintain the capstan moment of inertia is maximized to a practically obtainable value within the space envelope, and the roller radius is minimized to a smallest value which is compatible with eccentricity tolerance. Maximizing the moment of inertia minimizes the effect of torque disturbance, while minimizing the radius minimizes the torque disturbances due to film tension variations. A design study resulted in a moment of inertia of 10^4 gm-cm^2 and a capstan roller radius of 3/8 inch. It is expected that the capstan magnetic track positional error will not exceed 20 arc seconds, permitting a servo bandpass of 120 radians per second and a torque disturbance tolerance of 3000 dyne-cm (see Figure 13). The torque disturbance tolerance is being maintained by maintaining low bearing friction in the capstan and neighboring rollers and by improvements in the film tension sensing and control system. These latter improvements will be discussed in a subsequent section of this report.

Figure 14 shows the scanner breadboard in its present form. A Baldwin encoder disk, accurate to approximately 1 arc second has been incorporated into this breadboard for the purpose of making the initial magnetic track and for monitoring the velocity variations of the scanner. Figure 15 shows a drawing of the capstan with drag cup drive motor.

3. FILM TENSION AND LOOP LENGTH CONTROL

In System 1A and 1B film tension control was provided which equally distributed residual film tension on the forward and aft capstan drives. In System 1C, additional control will be utilized which also minimizes residual film tension at each of the two capstan drives. This is done primarily to minimize the torque required from the capstan drive motors. Figure 16 shows the System 1C film tension control system. Tension between the aft capstan and the take-up reel is made to be virtually independent of film loop length by utilizing a long spring. The supply and take-up reel speeds are controlled by the forward and aft loop lengths in the same manner as in System 1A and 1B. The forward and aft loop lengths are kept constant by the supply and take-up controls. The tension on the inter-camera loop is set to be nominally equal to the tension of the aft loop. This is accomplished by maintaining constant intercamera loop tension spring length. Constant spring length is maintained independent of loop length by means of a servo control utilizing servo amplifier SA1, Motor M1 and tachometer generator G1. Whenever the loop length changes, the spring length sensor develops an error voltage actuating servo motor M1 which in turn moves the rack and pinion mechanism controlling the length of the

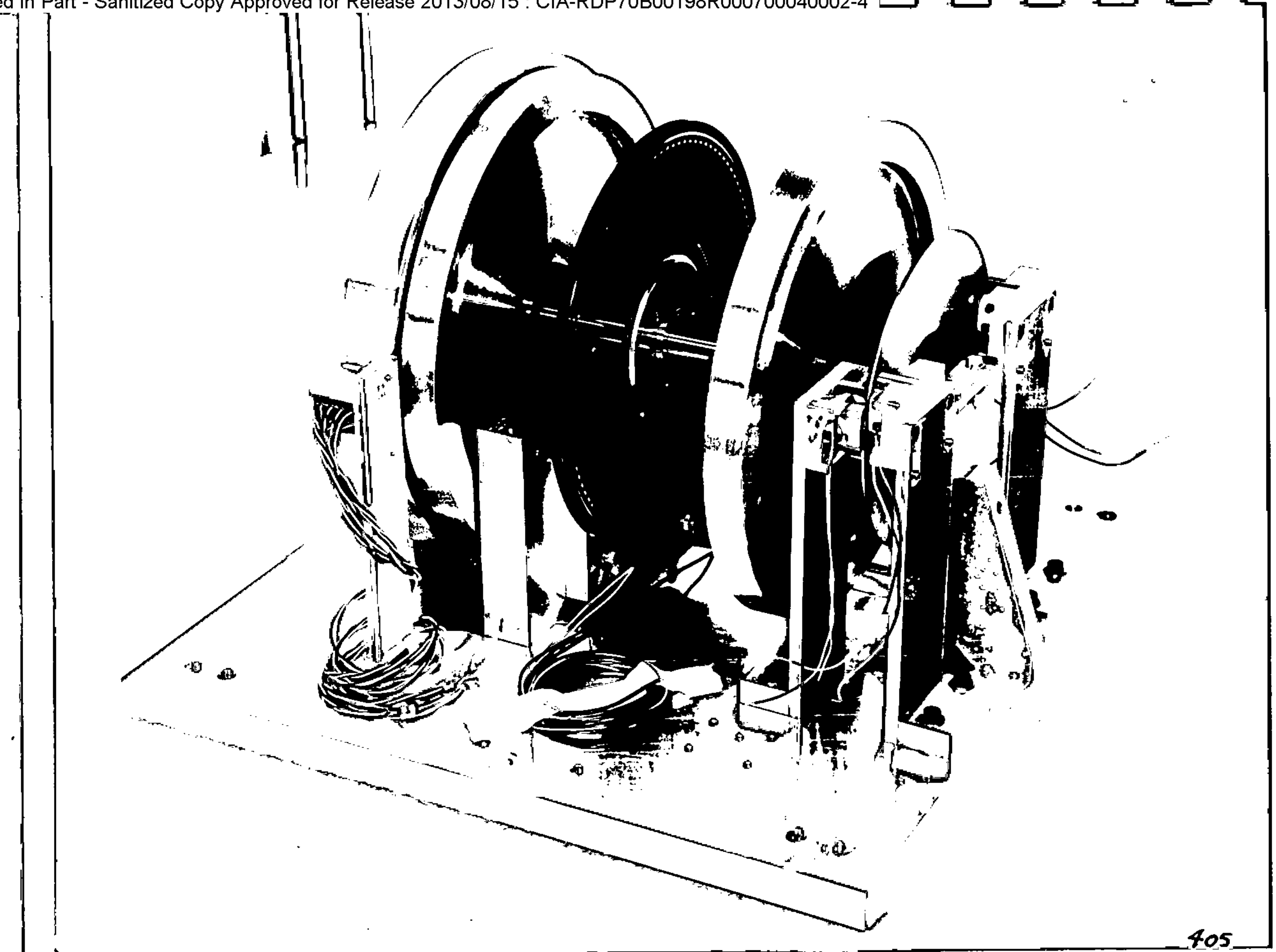
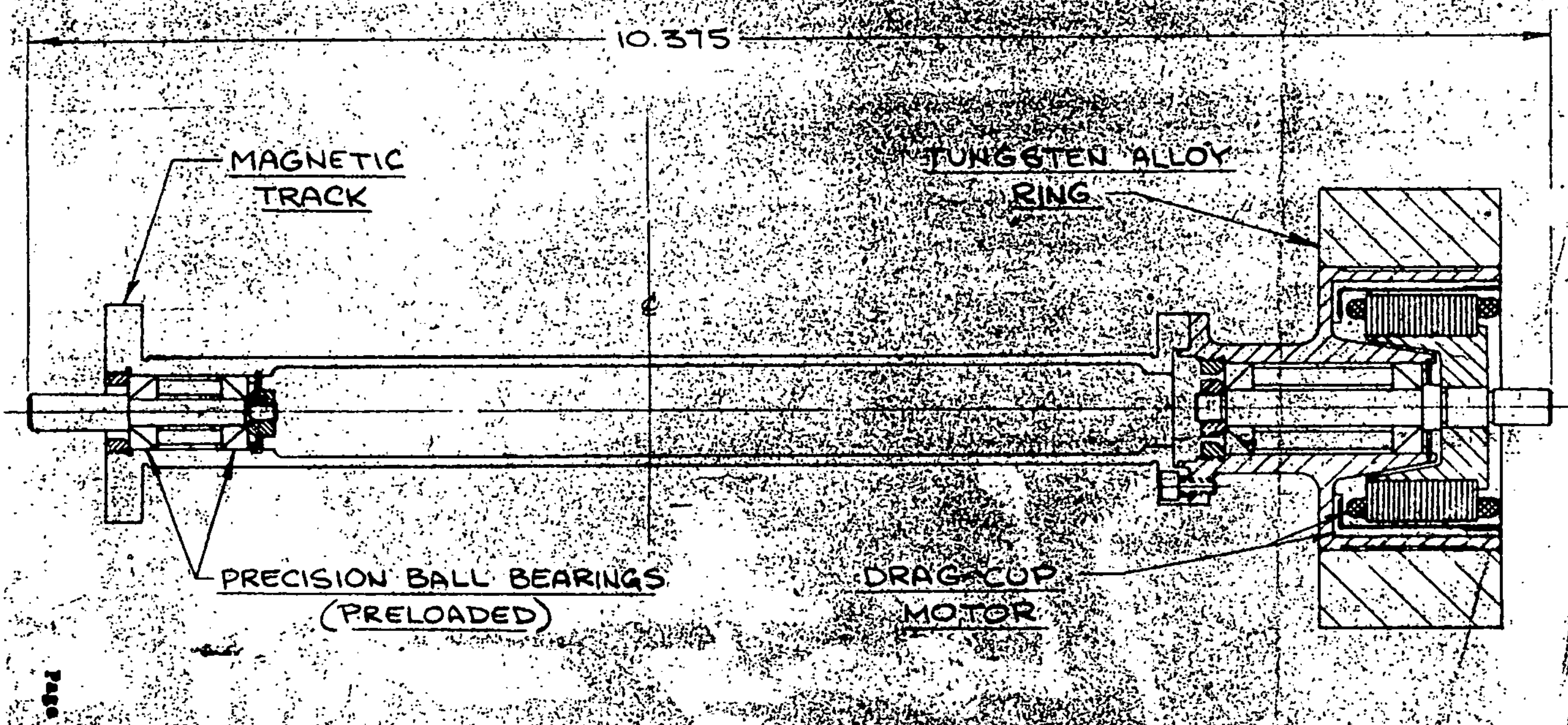
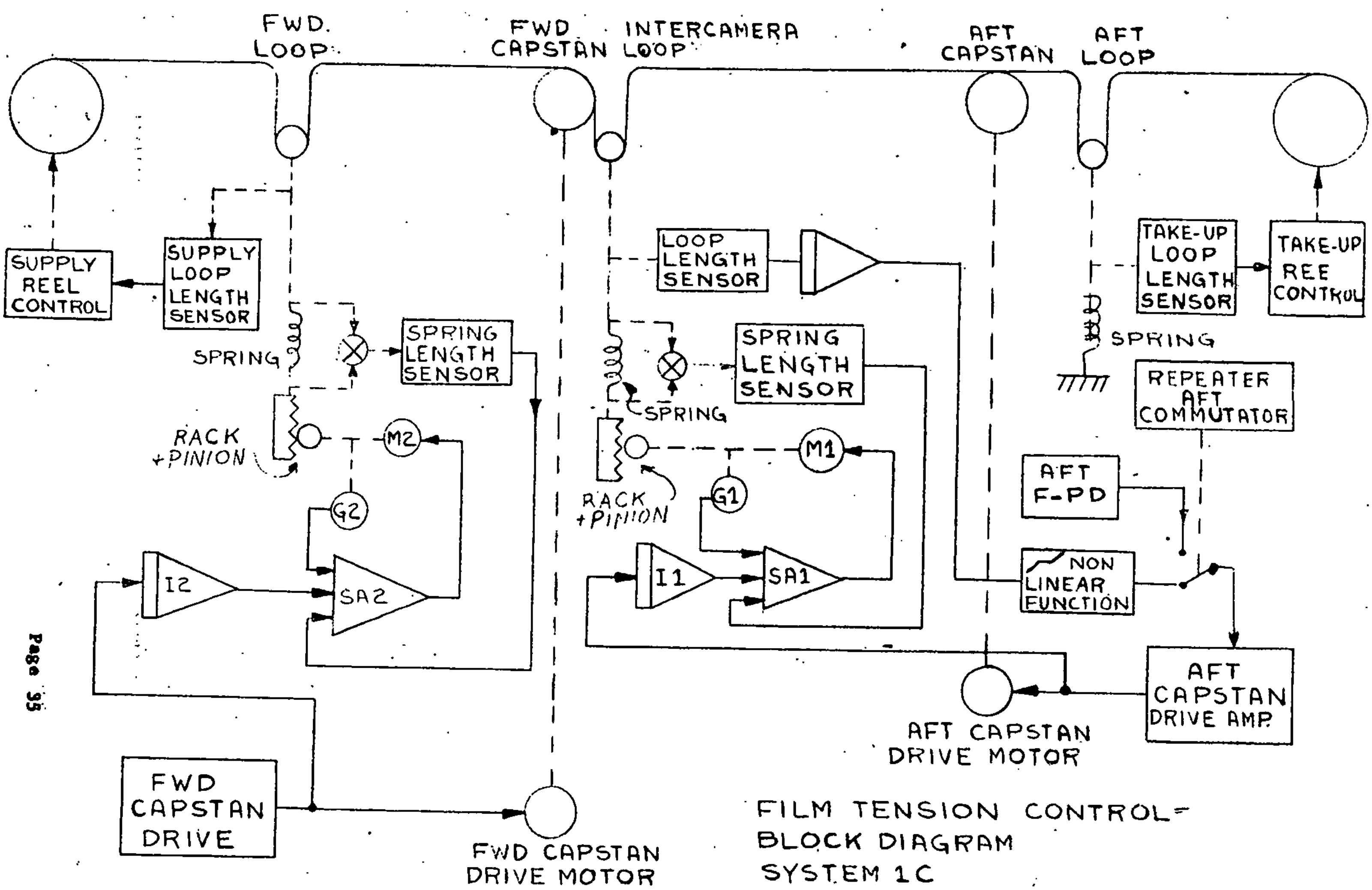


FIGURE 14



SYSTEM I.C — CAPSTAN-MOTOR ASSEMBLY



FILM TENSION CONTROL-
BLOCK DIAGRAM
SYSTEM 1C

FIG. 16

spring. Additional control is utilized to eliminate any residual film tension at the aft capstan. Residual tension will produce a counter-acting torque in the aft capstan drive due to the closed loop performance of that drive. This may be measured by an offset voltage of the aft capstan drive motor. The voltage on the capstan motor is fed through an integrator to SA1 which in turn initiates a change in inter-camera loop tension until the average torque supplied by the capstan drive is zero.

Similar control logic is applied for tension control of the forward loop, reducing the residual tension at the forward capstan drive to zero.

The inter-camera loop length is controlled by introducing positional shifts in the aft capstan drive during the non-active portion of the aft scanner cycle. It is necessary to introduce control logic which prevents the capstan drive command signal due to inter-camera look length error from fighting the command signal derived from the aft scanner-film drive synchronization system. This is accomplished by preventing any loop length error signal from actuating the aft capstan drive until the loop length error is of sufficient magnitude to permit a change of position of the aft metering roller to another stable position with respect to the aft scanner. The aft scanner magnetic track provides for 100 stable positions per revolution of the metering roller. A non-linear function is used to properly switch the loop-length error. The signal from this filter is switched into the aft capstan drive amplifier during the non-active portion of the scanning cycle. During the active portion of the scanning cycle the aft capstan drive receives the aft-scanner film drive sync. signal from the frequency phase discriminator (F-PD). The switching is controlled by

4. REPEATER PACKAGE

Systems 1A and 1B utilize a synchronizer package to provide control signals for the aft scanner and film drives. On the other hand the film and scanner drives in System 1C are completely divorced from a repeater to synchronizer package. It is, however, still necessary to repeat the position of the scanners in order to control the IMC resolvers, the capping shutters and the various commutator controlled switching functions. The control system for these functions will be almost identical to that of System 1A and 1B.

Referring to Figure 17, the repeater servo drive is controlled from the 4 cycle per revolution signal from the forward scanner. An area balanced positioned error signal is derived by switching that signal by means of the repeater motor driven switching commutator. Integral plus proportional control is used to derive incremental correction signals, the principal control signal being a voltage proportional to V/h.

5. STABILIZATION SYSTEM

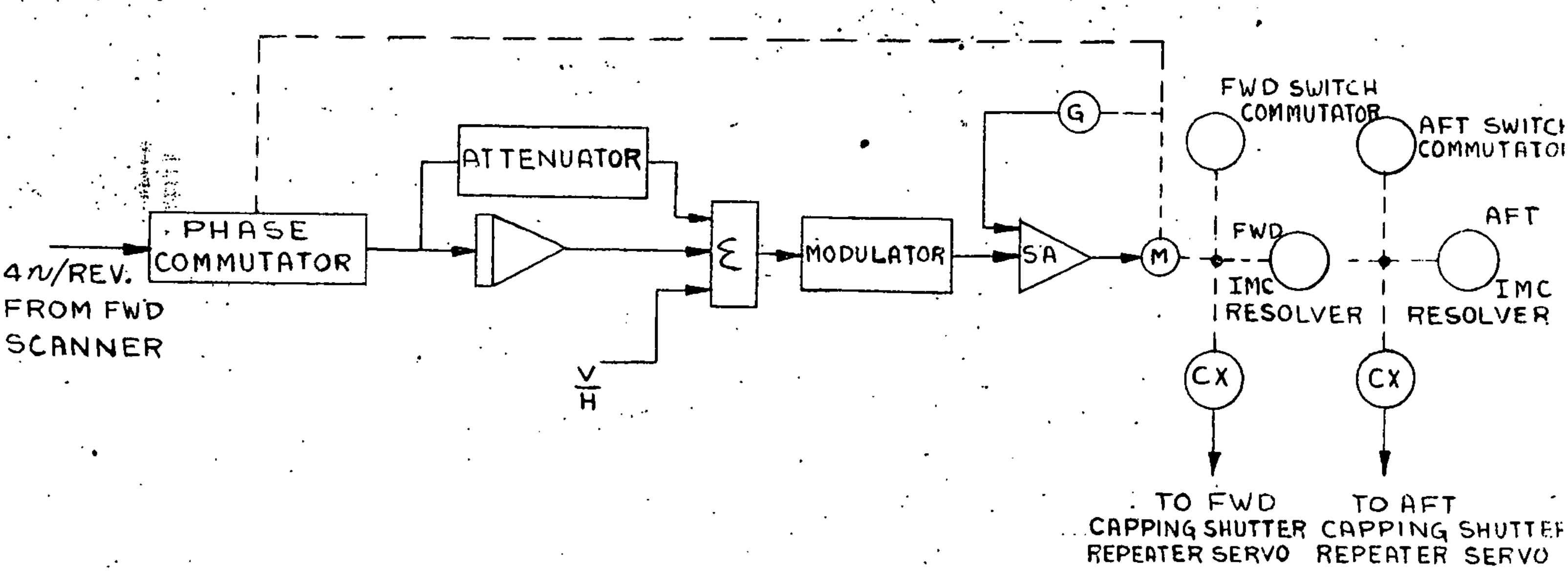
Our experience with the System 1A stabilization system demonstrated that the design goal of limiting camera pitch, roll and yaw rates to 35 arc seconds per second could not be met. Performance limitation is caused by the following:

A. High lateral acceleration sensitivity of the Sperry fluid sphere gyros.

B. Presence of uncontrollable sporadic noise in the gyros.

C. Susceptibility of camera mount to induced lateral resonance.

D. Action of dynamic weight shifter introducing lateral



REPEATER, SYSTEM 1C

FIG. 17

accelerations.

E. Relatively high bearing friction in knuckle.

F. Lateral acceleration producing bubble level signals.

Induced lateral mount resonance is considerably aggravated by lateral acceleration feedback through the gyros. The stabilization loop gain was limited by the performance of the gyros rather than by the bandpass of the dynamic weight shifting system.

Based on the experience with the System 1A stabilization system, the decision was made to incorporate drastic modifications in System 1C. The System 1C design philosophy consists of utilizing the following:

A. A flexure knuckle rather than the ball bearing knuckle. This minimizes torque disturbances into the camera.

B. Torque motors rather than dynamic weight shifter. This minimizes induced lateral mount acceleration and permits higher control loop gain.

C. Another rate gyro package having low lateral acceleration and high rate sensitivities.

D. Pitch and roll weight shifters and bubble levels to slave the camera vertical to the dynamic vertical.

The System 1C stabilization system has been breadboarded and tested using a dummy camera frame and mount and an interim rate gyro package using Minneapolis-Honeywell spring restrained rate gyros.

These gyros were initially procured for camera testing purposes. A floated rate gyro package suitable for field use is presently being procured from the Nordan division of United Aircraft. Breadboard results indicate that overall performance will be well within our tolerance specification.

Figure 18 shows a block diagram of the System 1C stabilization system. The gyros are aligned with the flexure axes (flexure pitch and yaw is rotated 45° with respect to the frame). Any rates sensed by these gyros produce compensating torques at the torquers.

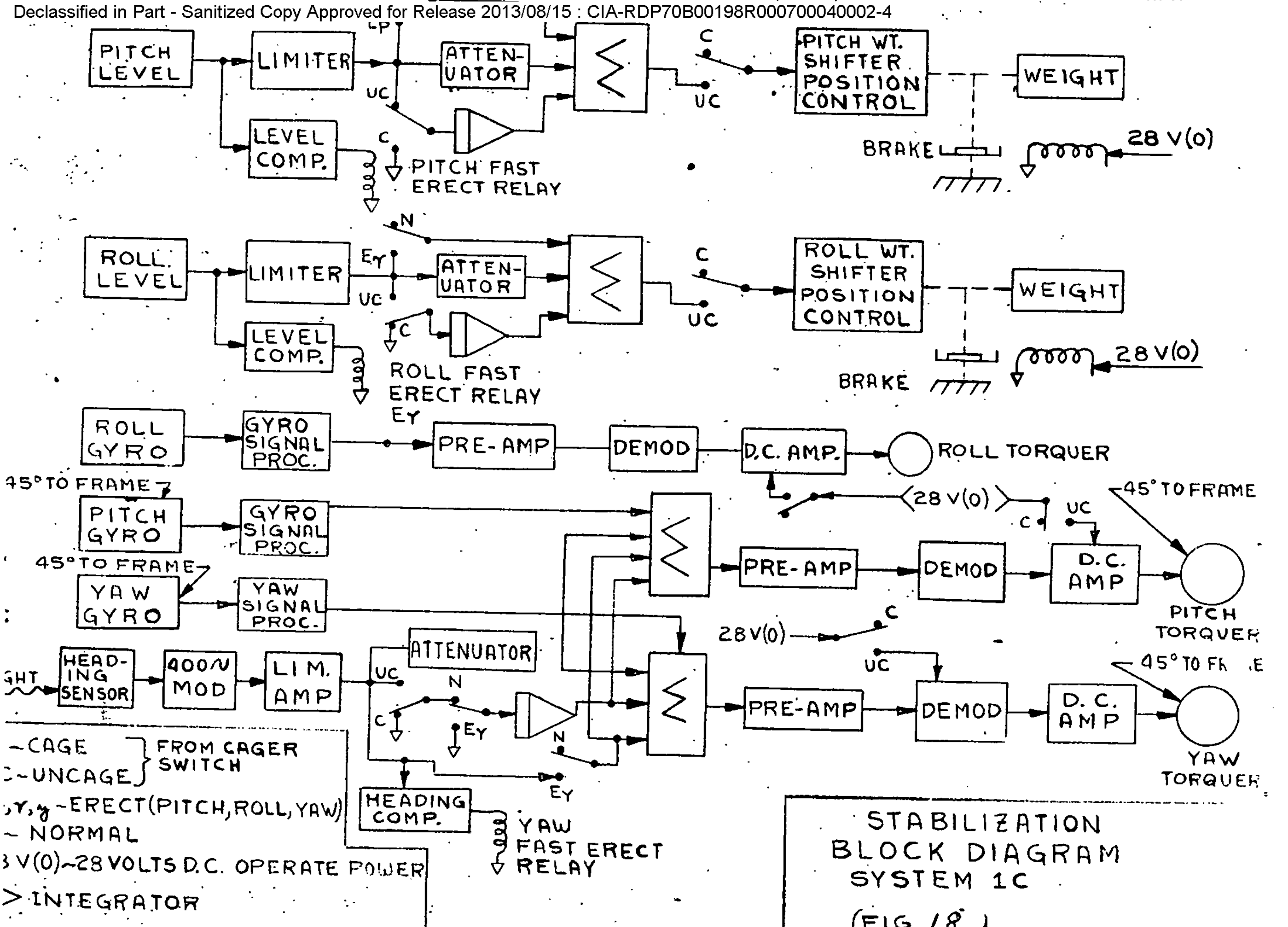
Verticality is maintained by the pitch and roll weight shifter loops utilizing pitch and roll bubble levels. During "cage" the weight shifter control is de-energized and the input to the non-volatile integrator is shorted to ground. During normal operation, integral plus proportional control is used to obtain stable operation. The integral term provides for zero angular positonal error due to any steady camera unbalance torque while the proportional term provides the equalization required for system stability.

Azimuth is slaved to the vehicle navigational system through an optical positional error sensor in the same manner as in System 1A and 1B. Any azimuth error excites both the 45° rotated pitch and yaw torquers.

Erection and caging logic is similar to that used in System 1A.

Figure 19 shows a picture of the flexure knuckle with torquers mounted on the rotational axes.

Figure 20 shows the results of breadboard measurements using a simulated 1C camera system. The residual net angular rates about the 3 camera axes were measured under simulated disturbances during 3 degrees



STABILIZATION
BLOCK DIAGRAM
SYSTEM 1C

(FIG 18)

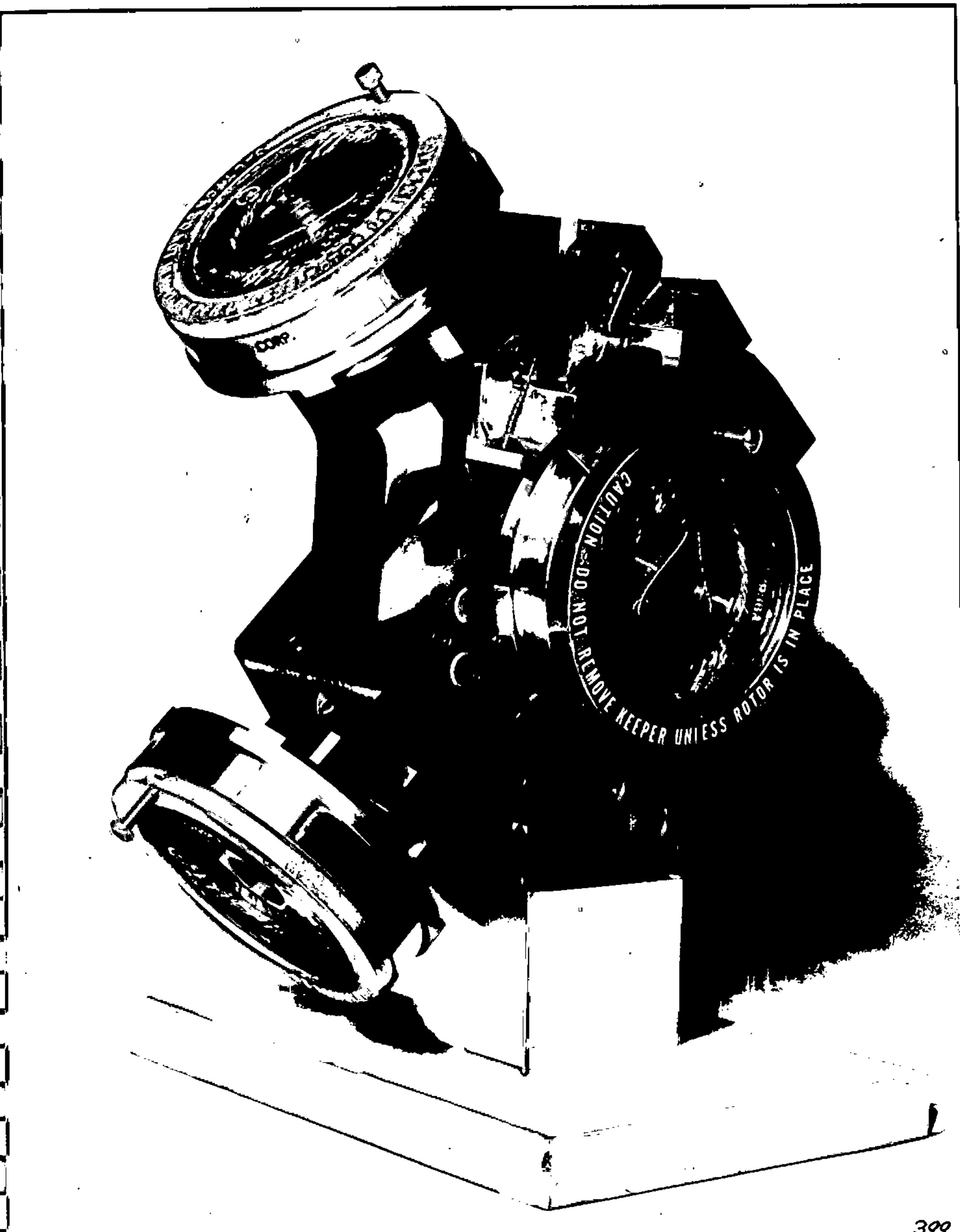


FIGURE 19

399

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

SYSTEM 1C BREADBOARD TEST MEASUREMENTS. INCLUDING SIMULATED EFFECT OF VEHICLE VERTICAL PITCH AND ROLL VIBRATIONAL SPECTRUM FOR 3 DEGREE OF PITCH AND ROLL, SIMULATED VEHICLE PITCH ROLL AND YAW RATES, PLUS EXPECTED INTERNAL CAMERA DISTURBANCES.

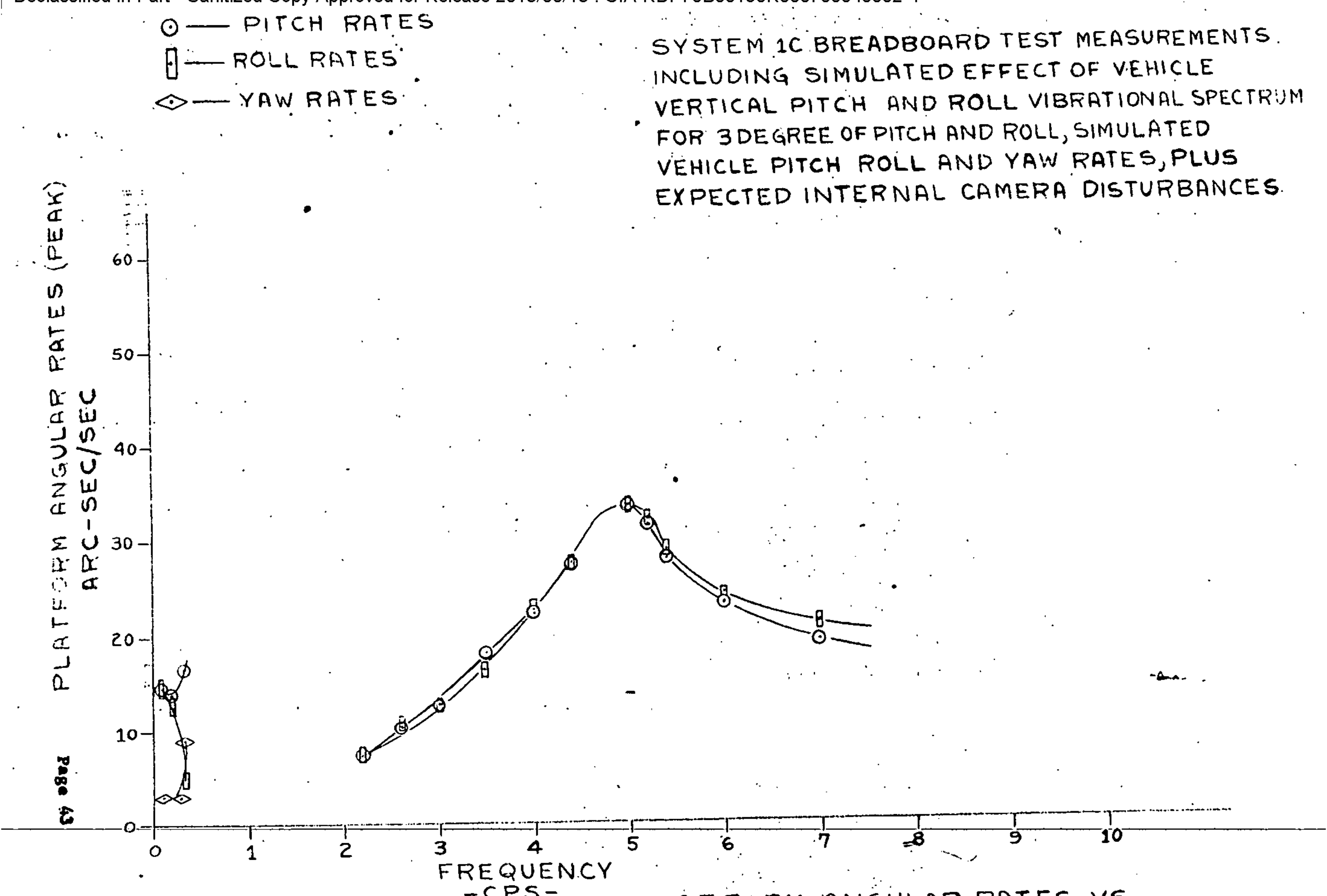


FIG. 20 PLATFORM ANGULAR RATES VS. DISTURBANCE FREQUENCY, SYSTEM 1C

of pitch and roll deflection. Disturbances included vehicle motion in pitch, roll and yaw, vehicle vibrational spectrum at the camera location, as well as all sources of camera input disturbances. The vehicle vibrational spectrum is as seen through the present isolators. The results indicate that system operation is well within the 35 arc second/second pitch, roll, and yaw rate tolerance.

6. 1C PLATFORM REDESIGN

A. Objectives

1) Reduce Hysteresis

Reduce structural hysteresis of optical bench alignment due to dynamic loads to less than one minute of arc.

2) Provide for New and Redesigned Subsystems

a) Stabilization

Provide for installation of roll axis torquer.

b) Material Transport

Provide for installation of 1C crossover network.

c) Electronics

Provide for installation of 1C electronic packages.

3) Reduce Production Time and Costs

Correct drawing errors, omissions and approve drawing clarity. Revise drawings to incorporate improved construction process techniques.

4) <u>Increase Strength</u>

Provide added structure to react the increased loads due to 20 per cent increase in system weight.

5) <u>Reduce Field Support Time</u>

Provide greater accessibility to components and reduce the need of optical bench alignments.

B. <u>Methods to Obtain Objective</u>

1) <u>Reduce Hysteresis</u>

a) Gussets were added to the optical bench mounting points.

b) The employment of one piece side panels with dowel pins.

2) <u>Provide for New and Redesigned Subsystems</u>

a) New center well casting.

b) New inserts and machining.

c) Lower electronic bridge.

3) <u>Reduce Production Time and Costs</u>

a) Simplification of bonding requirement.

b) Accurate detailed drawings.

4) <u>Increase Strength</u>

a) Redesign of front bulkhead casting and sheet metal extensions.

b) Gusseting of upper caging pin.

5) <u>Reduce Field Support Time</u>

a) Aft optical bench is adjustable.

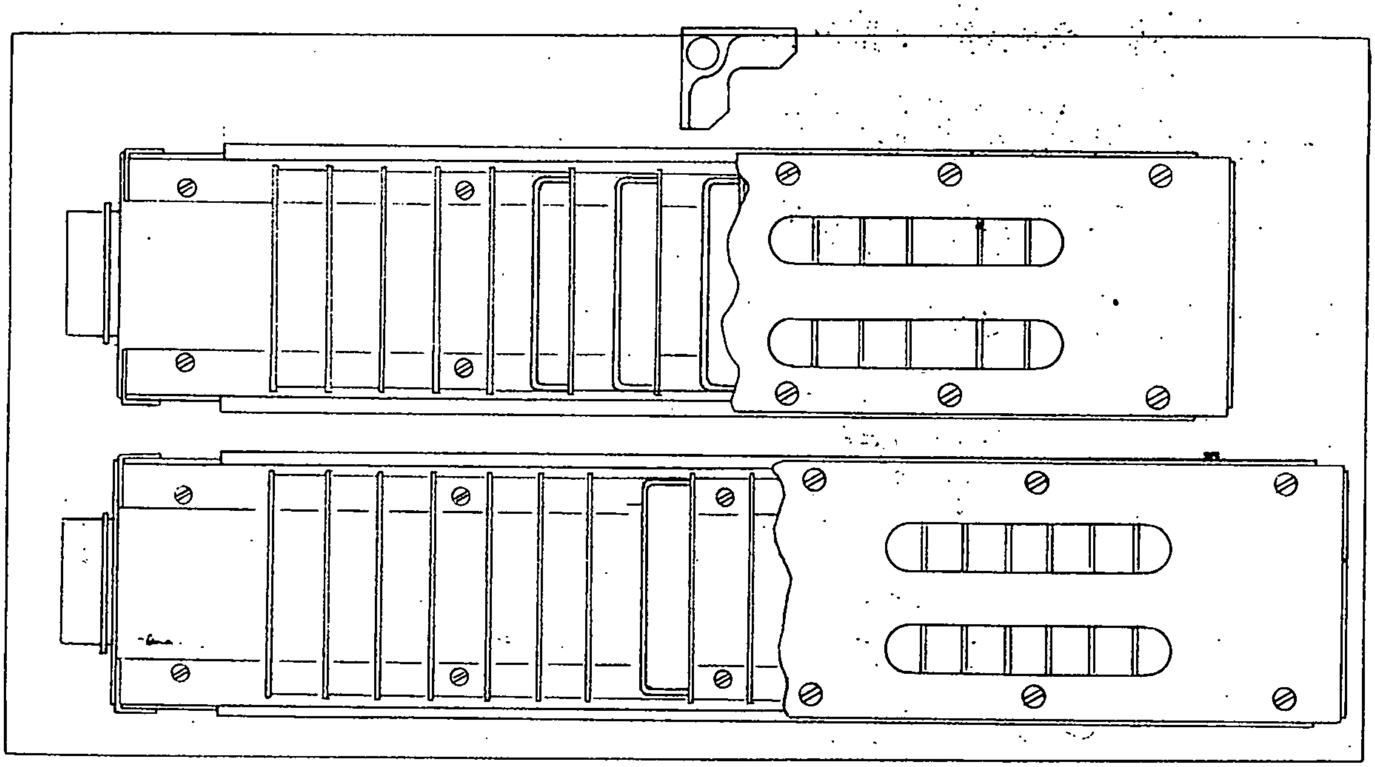
b) Electronic bridge removal has been simplified.

c) One piece side panels.

d) Gussets on optical bench mounting points.

7. ELECTRONIC PACKAGING

Electronic packaging in System 1C has been designed to improve field testing and maintainance, and to shorten assembly time. Figure 21 shews a sketch of the electronic deck layout. Electronic modules, such as amplifiers, deomodulators, etc., are being constructed on plug in boards which slide into racks. The entire electronic deck can readily be removed by unclamping from its mount and by loosening two large connectors. This permits rapid interchanges electronic decks. Circuit test points are brought out at convenient positions along the deck while less often used test points are on top of the electronic plug in boards. In addition certain critical test points are led across the gimbals for ready availability during final system checkout.



ELECTRONIC DECK LAYOUT. SYSTEM 1C FIG. 21

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

1C - Status (as of 1 Feb. 63)

The development, design, assembly and test of 1C has been scheduled on a CPM program. This shows the platform delivery (29 April 1963) and assembly as the critical path and predicts October shipment of the system to the Area. Assuming the predicted durations of activities used to produce this CPM schedule are correct, wiring of the electronic bridge is the next most critical item (i.e. has least slack time). Both of these areas are therefore being given maximum effort.

The areas where we can get hurt schedulewise, due to long lead time or development unknowns, are shuttle assembly, magnetic readouts from the scanners and the associated electronic controls, optical fabrication and component assembly, and delivery of electro-mechanical servo units. These areas are receiving secondary attention, and all other items are being taken care of as manpower and time permit.

The CPM schedule will be redetailed in March and thereafter as required. A copy is included in the rear of this report.

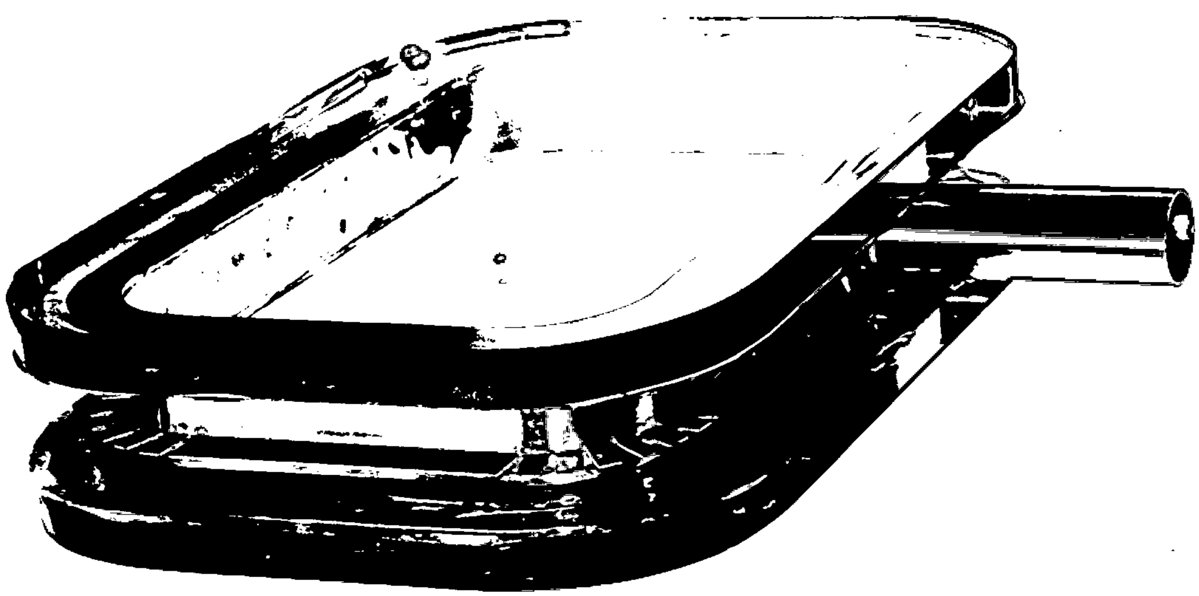
Window Status Report (through 8 Feb. 63)

During the last six months work toward completing the vacuum window has progressed very well. Two tight 7 x 10 windows were recently completed. Figure 22 shows one of these. This unit was temperature cycled from the mission profile twelve times and emerged with a leak rate well below the calculated tolerance limit. Another 7 x 10 window has recently been completed and is awaiting addition of the vac ion pump. This window will be used for more extensive thermal cycling tests.

The construction of the full size vacuum window is underway. A preliminary non-optical unit is currently nearing completion. All the processes and fabrication techniques for making the large window appear to be well under control. The large windows are similar to the smaller ones shown in Figure 22 except that they contain the thermal mount shown in Figure 23.

Investigation of several alternative sealing procedures including metalizing O-rings and gaskets and metalized rubber gask-o seals are continuing. The various techniques which have been considered so far are unsuitable for our requirements.

Two non-vacuum windows were constructed, installed in the hatch of Vehicle 3, and flight tested. The configuration is shown in Figure 24. These windows were also equipped with an adjustable thermal conductivity mount. The static optical resolution of these windows as tested in our sine wave response apparatus showed a transfer function



353

FIGURE 22

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

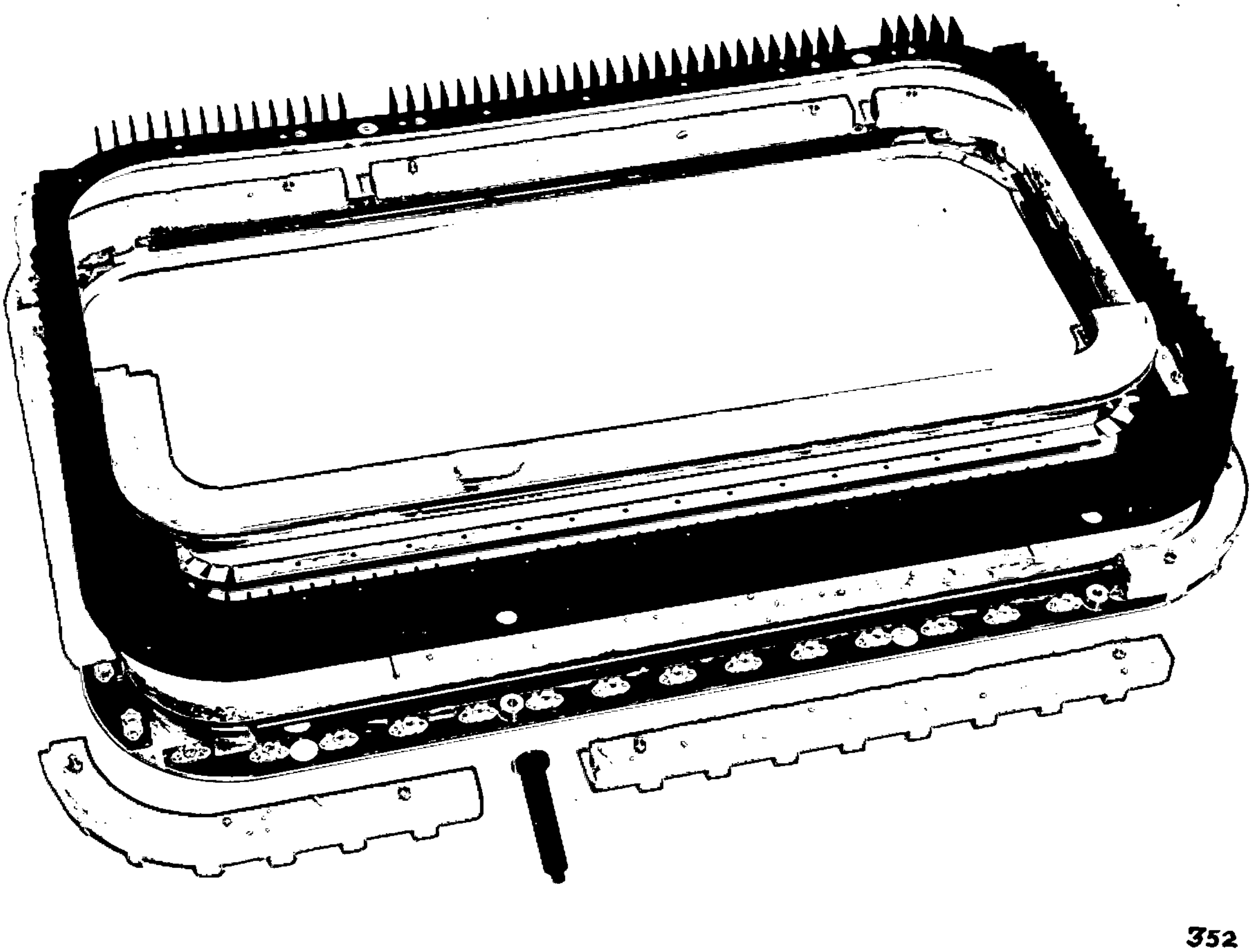


FIGURE 23

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

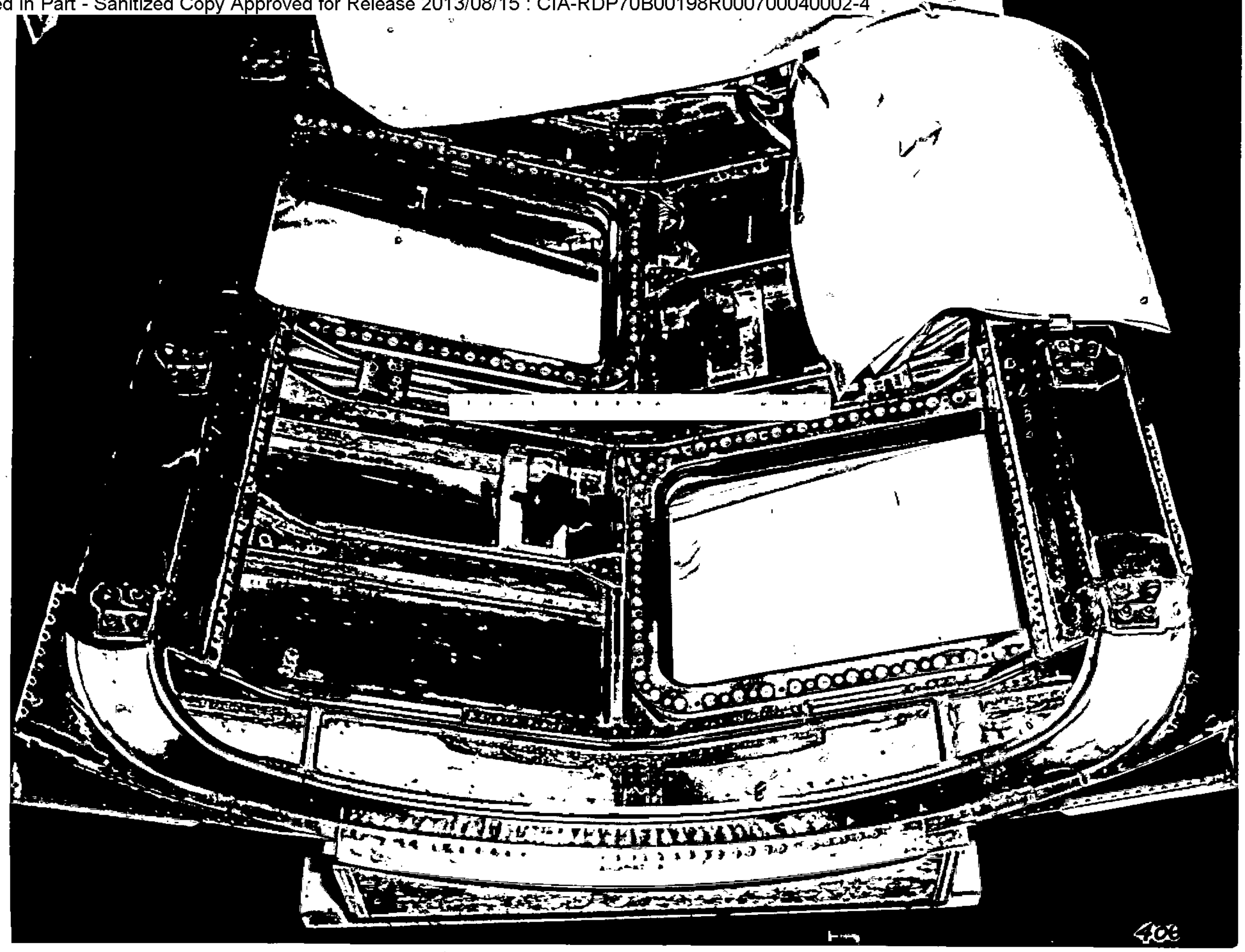


FIGURE 24

Declassified in Part - Sanitized Copy Approved for Release 2013/08/15 : CIA-RDP70B00198R000700040002-4

of essentially one up to frequencies corresponding to the limiting camera system frequency response. This means, in effect, that there was no discernable difference in quality with or without the window in the system, at least under laboratory conditions.

A modification of the present non-vacuum window, based on the concept of having lower inner glass temperatures by a means of a lower conductivity gas in the gap has been discussed and preliminary calculations have been performed. Vigorous pursuit of the construction of this alternative non-vacuum window is not being carried out at this time due to the necessity of concentrating our efforts on the assembly of the vacuum window.

APPENDIX - 1C Reliability Program

This section will discuss the Reliability Program on Special Projects and show how this program leads to better and more reliable design of the equipment.

The reliability group has evaluated and tested components for use in the system. Among these components tested are memistors. The memistor test program was an extensive program as the memistor is a new component, small and light in weight which could conceivably replace a number of much more complex electro-mechanical integrators with a considerable saving in power and weight. Results of the test program indicat that the memistor in its present state of development cannot meet the environmental requirements of the system and that more development of the component is required. As a result of the conclusions reached on the test program, memistors will not be used on the system.

The reliability group tests subassemblies for compliance to environmental specifications. An example of a subassembly tested is the start up package.

Failure reporting is used by the reliability group to find problem areas which were not readily apparent on paper. Failure reporting has lead to the review and improvements in the following areas: air bars, data chamber, synchronizer, and belt drives.

Many of the failure reports received to date indicate failures to human error. Recommendations are made wherever possible to avoid recurrence of that error.

In the future the reliability group will conduct tests on operational amplifiers, meter potentiometers and new electronic subassemblies.

Reliability will continue to aid in the selection of components and their evaluation. Reliability will also continue to use the failure report system to discover new problem areas and make recommendations for improvement of system reliability.